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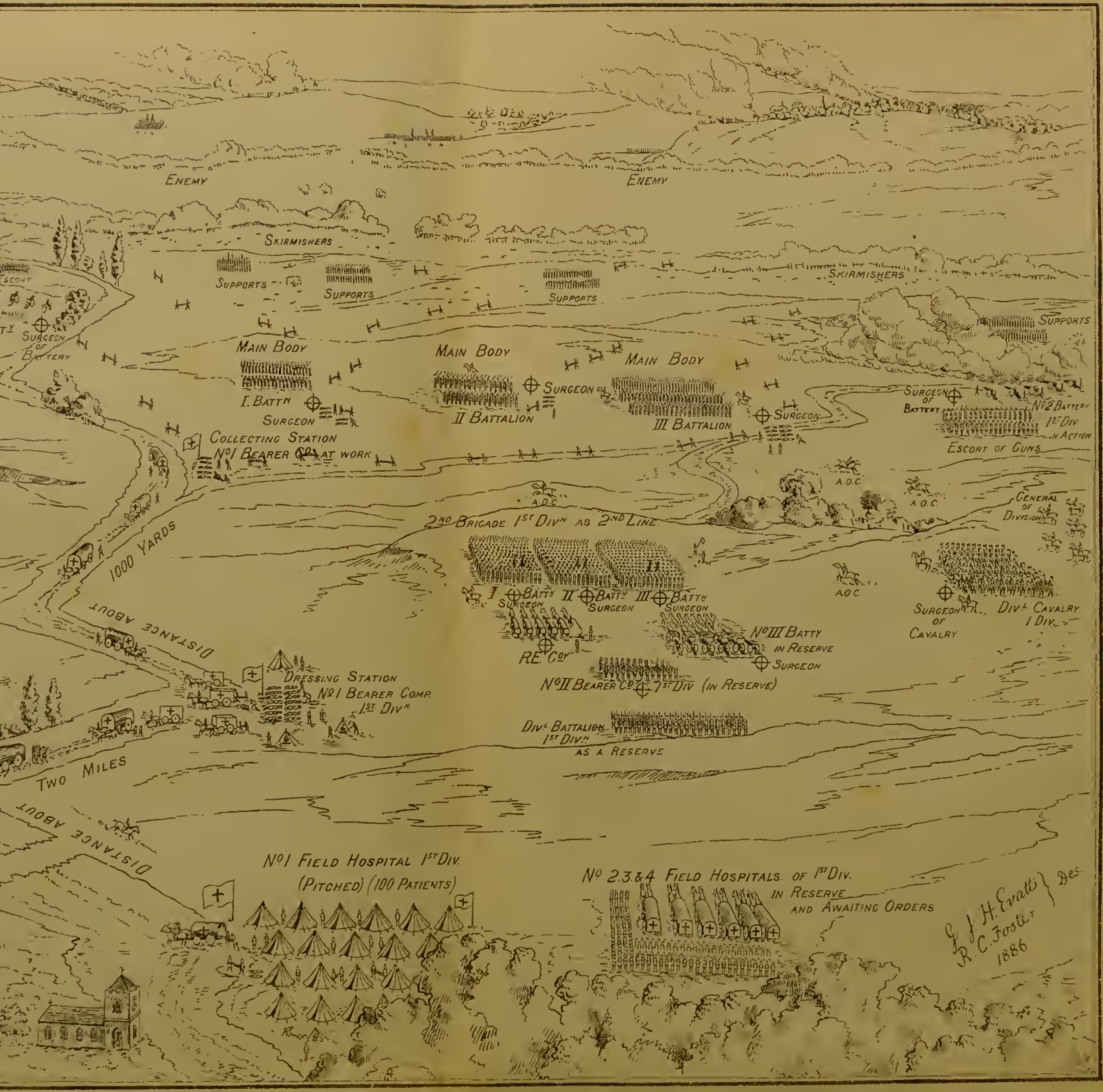
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THE

SURGEON'S POCKET-BOOK:

AN ESSAY ON THE

BEST TREATMENT OF WOUNDED IN WAR;

SPECIALLY ADAPTED FOR THE PUBLIC MEDICAL SERVICES.

BY

SURGEON-MAJOR J. H. PORTER,
LATE 97TH REGIMENT;
LATE ASSISTANT-PROFESSOR OF MILITARY SURGERY, ARMY MEDICAL SCHOOL, NETLEY.

Third Edition.

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1887.

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PREFACE TO THE THIRD EDITION.

IN revising and editing a Third Edition of the *Surgeon's Pocket-Book*, by the late Surgeon-Major J. H. Porter, M.S., I have endeavoured to preserve the general character and text of the book, and only to introduce such new matter as seemed requisite to bring the treatment of wounds up to date.

The results of the experience acquired by eminent German and Russian Army Surgeons in the field during the last Russo-Turkish Campaign have been embodied in the work, for these results have already exerted an influence on the practice followed in some recent wars, and cannot fail to make a great impression upon the surgical treatment of wounds and injuries in the future.

A sketch of the existing arrangements for treating the wounded in the field has been added. The paragraphs on wound-treatment have been re-written, and a short account of the "microbe theory" has been given, so far as concerns its application to the causes of wound-mischief and the best means of averting them.

The paragraphs on gun-shot injuries of joints and shot fractures have been revised, as well as those relating to amputations, excisions, and surgical operations in general.

The rules for the deligation of the larger arteries have been mainly borrowed from Mr. Heath's classical work on *Operative Surgery*.

The paragraphs on traumatic infective disease and septic poisoning have been entirely re-written. A few hygienic memoranda have been added to the hand-book, which it is thought may be useful at a time when reference to larger works is not available. For the supervision of these memoranda I am indebted to the kindness of Professor F. de Chaumont, F.R.S.

A list of the antiseptic materials provided for the Army Medical Service is given in the Appendix, and the place where each of these materials may be found in the field-cases of surgical equipment is also indicated.

A copy of a recent order to the Medical Department of the German Army (May 1886), concerning the preparation of antiseptic materials when an army is ordered to take the field, and the methods of using them in field practice, has also been added, as it contains many points that, I believe, will be found of interest to surgeons of our own services, for the translation of this I am indebted to my friend Mr. Borchert of the Army Medical School.

The table of the rations which were arranged for the Troops, under the special conditions in which they were placed, when proceeding up the Nile in boats in 1884-85, which forms the last section of the Appendix, will possibly interest many Medical Officers.

I must now add how greatly I am indebted to Surgeon-General Sir T. Longmore, Knt, C.B., for the help so freely given to me in the preparation of this work, and for the many suggestions which his great experience has prompted him to offer, and of which I have been only too glad to avail myself.

C. H. Y. GODWIN.

OAKHURST, NETLEY,
December, 1886.

PREFACE TO THE SECOND EDITION.

In issuing a New and Revised Edition of his little Treatise, the author can wish for it no better reception than was so kindly and heartily accorded to the First. The preparation of the work has been a source of great pleasure to him, and he has spared no pains to render it in all respects more complete and helpful than the original Essay, and therefore more worthy of the place which it aspires to hold in the Field-Service Equipment of the Military Medical Officer.

Many new Illustrations of Extemporised Splints, Stretchers, and other useful appliances have been added. Important details of practice, gleaned from the following sources (as well as from others too numerous to specify in full), the author hopes may be found useful in determining the best course to pursue in circumstances of doubt or difficulty, and more especially when the Surgeon is compelled to trust entirely to his own resources and judgment:—

Circular No. 2: *Reports on Excision of the Head of the Femur for Gun-shot Injury*, by Mr. G. A. Otis of the U.S. Army;

Professor von Langenbeck's work, *On Gun-shot Injuries of the Hip-Joint* (the result of experiences gained during the Franco-German War of 1870–71);

Medical and Surgical History of the American War of the Rebellion, part ii., vol. 2, 1876; *Surgical History*—"On Wounds of the Abdomen, Pelvis, Shoulder, Elbow-, and Wrist-Joints;"

Professor Longmore's classical and comprehensive *Treatise on Gun-shot Injuries*, 1876;

Professor Esmarch's *Handbook of Technical Surgery*, 1877 (whence several engravings have been derived);

and, lastly, the results of personal visits to the Exhibitions at Brussels, 1876, and Paris, 1878, where numerous ingenious inventions for the relief of the sick and wounded in war were exhibited by many of the most distinguished Surgeons, Naval and Military, of well-nigh every civilised nation in the world.

A short Memorandum kindly contributed by the Author's friend, Professor de Chaumont, will be found under the important subject of Water-Supply and Filtration.

J. H. PORTER.

Cabul,
September, 1879.

PREFACE TO THE FIRST EDITION.

HAVING had some experience in the treatment of wounded soldiers during the Crimean Campaign, the Indian Mutiny, and the Franco-German War of 1870-71, I was induced to compete for a prize offered by Her Majesty the Queen of Prussia and Empress of Germany, for the best Essay on the "Practical Treatment of the Wounded in War."

The judges, Professors Billroth of Vienna, Baron von Langenbeck of Berlin, and Socin of Basle, awarded a prize to my Essay, which I now publish at the earnest request of my friends in the Medical Profession.

The great difficulty of preparing a work to meet the ever-recurring emergencies of war will, I trust, be sufficient excuse for any shortcomings which may be found in it. The army surgeon of the present day has, as a rule, to deal with the wounded under very different circumstances from his predecessors. Railways, improved transport and field appliances, as well as the privileges of the "Geneva Convention," have given to wounded soldiers better prospects of recovery in many respects; but experience has sufficiently proved that modern surgeons may still be placed, under exceptional circumstances, in no better position for the care of their wounded than were those of former days. On this account I have detailed the surgical rules of the older surgeons, as well as of those of the present day, presuming that my readers will not omit to consider the circumstances of each particular case that falls under their care, and be guided in applying the rules given in this Manual in accordance with them.

Take, for example, the circumstances of men with wounds in or near to a Continental town, with every comfort and appliance at hand, and those of others with similar wounds on such a field as that of Alma, Magdala, or Coomassie, with the necessity for immediate long transport and exposure—how different must be the plans of treatment adopted in some of these injuries!

I have included several subjects which might at first sight be considered extraneous to the purpose of a surgical manual; such are—a scale of hospital diets, construction of cooking-places, of camp ovens, extemporary water-filters, and latrines; but, from experience in the field, I know how important for the present comfort of patients and the ultimate results of their injuries it is that the surgeon should have memoranda on these matters at hand for easy reference. Information on these points formed a portion of the contents of the original Essay, but to the present publication I have also appended the Formulary of Prescriptions which is now in general use in Military Hospitals. I have found the use of this formulary a means of facilitating work and saving time, and have therefore thought it would prove a convenient addition to the Manual.

In the preparation of this Essay I lay no claim to literary merit or originality. My object has been simply to present to the surgeon such information as I myself found the want of during my campaigns; and in doing so I have extensively made use of the labour of others, to whom I am indebted, but who, like myself, will, I am sure, be well rewarded, if their efforts tend to mitigate in the smallest degree the sufferings of the unfortunate wounded in war.

J. H. PORTER.

WOOLSTON,
May, 1875.

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THE
SURGEON'S POCKET-BOOK.

INTRODUCTORY GENERAL REMARKS.

The duties of the Army Surgeon, at all times responsible, are more especially so in time of war, and much of the success of troops is dependent upon the manner in which they have been executed.

Forethought is required in making suitable suggestions for the preservation of health; and, when sickness and wounds occur, proper organisation for the care and treatment of the sufferers. It is not always possible that officers commanding forces in front of an enemy can attend to the strict rules of hygiene, on account of being obliged to take up certain positions with regard to tactics, it is therefore the duty of the responsible surgeon to make the most of such positions, and with the means at his disposal offer such suggestions as will conduce to the health and comfort of those under his care. It is on these occasions, when difficulties have to be overcome, that the resources of the Army Surgeon are severely tested, and his genius and training brilliantly brought out.

Acquaintance with Intended Military Movements.—To facilitate the duties of the Medical Staff during active operations, it is most desirable that the responsible medical officer should be informed by those in authority as to the probable movement of troops, and that he should have some idea of the strategy intended. By being in possession of such information, he may be able to lay out plans for the position of field hospitals, and possibly prevent his ambulances from blocking up roads, or otherwise causing inconvenience.

Organisation of Transport.—Rules and regulations exist in all civilised countries for the organisation of transport, supply of stores, comforts, and medicines, also of surgical instruments, under their respective departments. Surgeons, therefore, should make themselves acquainted with the *construction of all transport* for their sick and wounded, so that, in the event of accidents in moving, they can in some measure render temporary assistance, much suffering and delay being frequently occasioned by ignorance on the part of attendants, in consequence of their being unable to set to rights trivial accidents.

In taking the field, either in immediate charge of troops or attached to hospitals, it is essentially necessary to have a careful inspection of every article taken over; to become acquainted with the position or *locale* of medicines, instruments, medical comforts, bedding, cooking utensils, and such articles as may be required in a hurry, or at night; to detail each medical officer, non-commissioned officer, or hospital orderly to his respective post, and to see that they are acquainted with their duties. The necessity for doing so cannot be too strongly urged, as it is only by each individual knowing exactly what his duties are, and the relative position of articles in charge, that great confusion, unnecessary unpacking, and trouble can be prevented.

Surgical Instruments should be special objects for care, as without their being in good order the surgeon is of very little use on active service in the field. Guthrie justly remarks, that "a surgeon without his apparatus and equipment is little better than a battery without ammunition." In dry climates, surgical instruments can be kept free from rust by thorough drying after use, the case being afterwards enclosed in waterproof covering. In moist climates, they should be smeared with mercurial ointment, rubbing off the same when required for use.

The Art of Extemporising Appliances.—The extemporaneous construction of splints, pads, cushions, field-kitchens, hospital huts, latrines, bed-cots, litters, carts, &c., should engage the earnest attention of the army surgeon, as he may be placed in positions where regular artificers are not available. With his knowledge on these matters, and the aid of a few orderlies, he may be able to secure shelter, properly-cooked food, and comfort in a short time. He should also be acquainted with the method of pitching tents and marquees, and the amount of space required for each.

It may be remarked that these matters do not belong to the duties of the army surgeon, but on service in the field he will find that, unless he is capable of supervising and directing them, much must be left undone, and those under his care must consequently suffer. And if the usual resources fail or are not at hand, he should, by extemporaneous expedients, succour the wounded and relieve the sick.

An acquaintance with the dress of the soldier may assist in discovering some cause for inability to march or keep up with the others, such as tight collars, or badly-fitting boots, wrinkles in trousers, &c.

The carriage of sick and wounded on stretchers is highly important, and the surgeon should be in a position to instruct those about him, in the event of regularly-trained men not being available.

A stretcher section consists of four bearers, two of whom carry the stretcher and two act as a relief during the transport, and assist in placing upon the stretcher men who have met with serious fractures or other injuries.

Before attempting to remove a badly-wounded man from the spot where he has fallen, the stretcher should be brought close up to him. The wounded man should not be carried by hand further than can be avoided. In placing the stretcher for this purpose, it should be laid by the side of the patient, according to present regulations; but in some systems it is directed to be placed at the head of the patient, in a line with his body.

The following instructions have been laid down by Sir Thos. Longmore for the proper carriage of stretchers:—

The front and rear bearers of the conveyance must start with opposite feet. They must not move "in step," but, on the contrary, must march out of step, or, as the ordinary expression is, must "break step." If the man in the front steps off left foot forward, the man in the rear must step off at the same moment right foot forward, or *vice versâ*, and this broken step must be maintained throughout the whole distance of the transport.

The bearers must march with a steady but easy step, particularly avoiding that elevation of their bodies which is caused by springing from the fore part of the feet. The foot should be planted without any wavering on the ground at each step, and in moving forward it should only be raised sufficiently to clear the ordinary impediments on its surface. Some bearers, unless this rule is enforced, will make a slight spring in their movements, which spring is of course communicated to the more or less pliable conveyance they are carrying. They do so in the belief that the weight is sustained more easily in consequence of the elastic movement which is thus obtained, but they take no note of its ill effect on the person conveyed. Whether even or uneven as regards measure of time, great care must be taken that the steps of the front and rear bearers are invariably even and alike in distance. If the steps do not well and accurately agree in length, there will constantly be a hasty "catching up" of one or other by his fellow-bearer, and the stretcher and patient will be jolted on every occasion when an effort is thus made to re-adjust the distance. If the bearers march with an exactly corresponding step as regards length, this source of disturbance will be avoided.

When forming a stretcher section, as far as circumstances permit, men nearly of the same height and strength should be selected for acting together. When a stretcher is supported by men of equal height and proportion, if the ground be level, the stretcher will necessarily assume a horizontal position also, and men possessed of like degrees of strength will carry the weight and move together more evenly. If the ground be uneven, the bearers will have to mutually adapt the height of their respective ends of the conveyance to the irregularities in order to preserve its level condition.

When slings or shoulder-straps are used to assist the bearers in carrying stretchers, care should be taken at starting that they are buckled so that the parts supporting the poles are at equal distances from the surface of the ground.

As most ground over which wounded men have to be carried is likely to present irregularities of surface, it becomes an important matter for bearers to practise the carriage of the stretchers so as to acquire a facility of keeping the stretcher level, notwithstanding that the ground is uneven.

If the ground over which the conveyance has to pass presents a general ascent, and the bearers are of different heights, then the rear or No. 3 bearer should be the taller and stronger man, for his greater height and the greater strength of his arm will be useful in supporting and raising the stretcher up to the level of the end carried by the foremost man. The weight of the stretcher will naturally be thrown in the direction of the man on the lower level.

If the ground presents a general descent the front or No. 1 bearer should be the taller and stronger, for the same reasons as those just given as regards the No. 3 bearer under the opposite circumstances.

A sick or wounded person on a stretcher should be carried, if the ground be tolerably level, with his face looking toward the direction in which the bearers walk. The front or No. 1 bearer then supports the end of the stretcher at which the patient's feet are placed; the bearer near the patient's head is the rear bearer or No. 3.

If the bearers have to carry the stretcher up hill, the front bearer should support the end of the stretcher on which the patient's head is placed, excepting under the following circumstances:—

If the bearers have to carry the stretcher down hill, the rear bearer, or No. 3, should support the end on which the patient's head is placed.

The reverse of these positions should be assumed by the bearers both as regards going up hill and going down hill, in case the patient being carried is suffering from a recent fracture of the thigh or leg. The patient's comfort and welfare will be best consulted as a general principle by the arrangements suggested in the previous paragraphs. Although under all circumstances the level position should be sought for as much as possible, still, if the slope of the ground be such that it cannot be attained, it appears desirable that the inclination downwards should be towards the feet rather than towards the head of the patient. But with regard to the exceptions just named, a reverse position of the patient is directed in order to prevent the weight of his body pushing the upper end of the broken bone down upon the helpless and motionless portion of the limb below the seat of the fracture.

No attempt must be made to carry a helpless patient over a high fence or wall, if it can possibly be avoided; it is always a dangerous proceeding. The danger is of course increased in proportion to the height of the wall or fence. If the fence or wall be high, either a portion of the wall should be thrown down, or a breach in the fence made, so that the patient may be carried through on a stretcher; or the patient should be carried to a place where a gate or opening does already exist.

In crossing a ditch, dyke, or hollow, the stretcher should be first laid on the ground near its edge. The first bearer then descends. The stretcher with the patient upon it is afterwards advanced, the first bearer in the ditch supporting the front of the stretcher, while its other end rests on the edge of the ground above. While thus supported, the second bearer descends. The two bearers now lift the stretcher to the opposite side, and the fore part being now made to rest on the edge of the ground while the rear part is supported by the second bearer in the ditch, the first bearer is left free to climb up. The stretcher is now pushed or lifted forward on the ground above, and rests there while the second bearer climbs up. The two bearers then carry the stretcher on.

On no account should a stretcher be permitted to be carried on the shoulders of two or four bearers. The evil of such a proceeding is not only that it is difficult to find several bearers of precisely the same height, so that a level position may be secured, but also that the wounded or sick person, if he should happen to fall from such a height, owing to the helpless condition in which such a patient usually is, is not unlikely to sustain a serious aggravation of the injuries he may already be suffering from. Moreover, one of the bearers of the stretcher ought always to have his patient in view, so as to be aware of hæmorrhage, fainting, or other changes requiring attention, taking place, and this cannot be done when the patient is carried on the shoulders.

Means of Extemporaneous Transport.—There are occasions when a sufficient number of stretchers, either "ambulance" or "hospital," may not be at hand; it will then be necessary to adapt oneself to circumstances, and take advantage of such means as may be present. If near shipping, hammocks and cots may be converted into stretchers by being suspended from single poles, as in figs. 1 and 2, or by a little management they can be arranged to be carried between two poles. The former plan was adopted during the late expedition of British troops in Western Africa, and Staff Surgeon H. Fegan, R N., mentions that each hammock was fitted with a pillow made of another spare hammock, which, in the event of any emergency, could be easily slung from tree to tree, and thus often proved very useful.

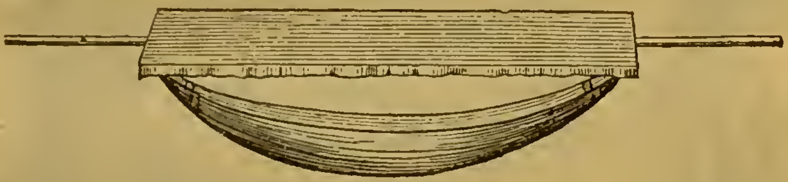

Fig. 1.

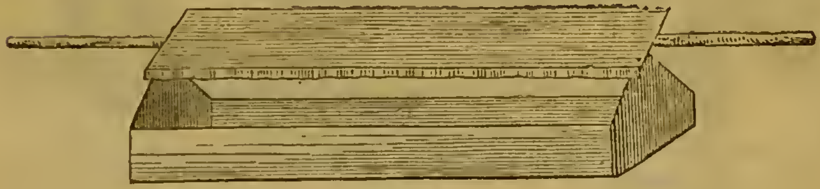

Fig 2.

Hammocks and Cots used during the Ashantee War, 1873-74, arranged with shades for protection from the sun. (From drawings by Surgeon J. Fleming)

The following stretchers may be constructed on the spot from materials generally available :—

"Blankets, by having a loop sewn at each corner, can with two poles or two rifles make temporary conveyances. A loop should be sewn at each corner, and the blanket be then doubled over so that the two loops at each end are brought together; a pole or rifle can be passed through the four loops on one side, and another passed within the doubling of the blanket on the other side.

"In urgent cases a blanket may be used as a means of carriage by four men, one taking hold of each corner. It must first be spread out upon the ground, and the patient laid gently on it in a suitable direction."

Mr. Hamilton of the U.S.A., in writing of blanket litters, recommends "cedar as the best for carrying poles, being light, elastic, and strong. Next to these, pine or ash. Two cross-bars are sufficient. The blanket may be rolled in before the cross-bars are made fast, or, the cross-bars being first secured, the blanket may be 'knotted up' by strings, and if strings cannot otherwise be procured, they may be made by tearing strips from the margin of the blanket."

Dr. G. Suckley, U.S.V., says "that he has occasionally in frontier service constructed a temporary litter of two poles cut from the forest, these being laid upon the edges of a blanket, rolled in, and finally made fast with strong twine, by puncturing the blanket at intervals of a foot along the sides of the poles, and tying the twine strongly on the outside."

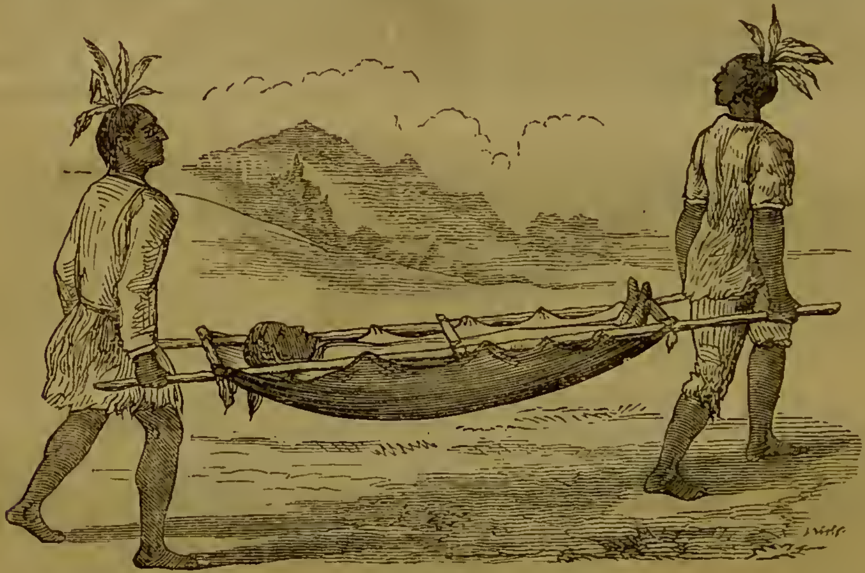

Fig. 3.

Galton recommends a temporary stretcher to be constructed in the following manner:—"Cut two stout poles, each 8 feet long, to make its two sides, and three other cross-bars of 2½ feet each, to be lashed to them. Then, supporting this ladder-shaped framework over the sick man as he lies in his blanket, knot the blanket well to it, and so carry him off palanquin-fashion, as represented in fig. 3. One cross-bar will be just behind his head, another in front of his feet; the middle one will cross his stomach and keep him from falling out, and there will remain two stout handles for the carriers to lay hold of. A kind of waggon-top can easily be made to it with bent boughs and one spare blanket."

"Oat or corn sacks will serve as a canvas bottom to a temporary litter, or, in an emergency, any old pieces of cloth—the fragment of a tent, an overcoat, or even a pair of pantaloons; some of which things can almost always be found on a battlefield. Litters thus constructed also make excellent beds in a hospital tent, when placed upon four crotched sticks driven into the ground."

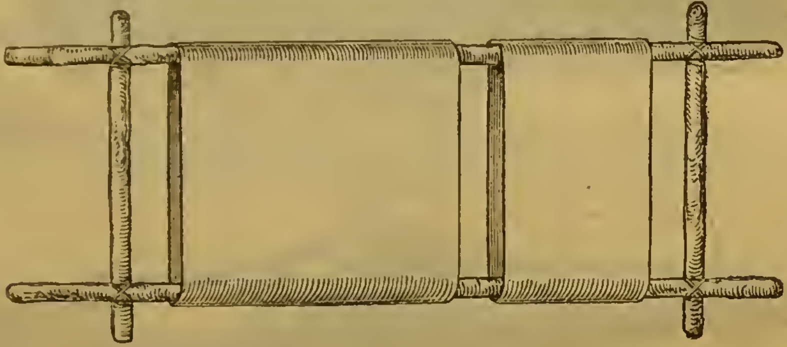

Fig. 4.

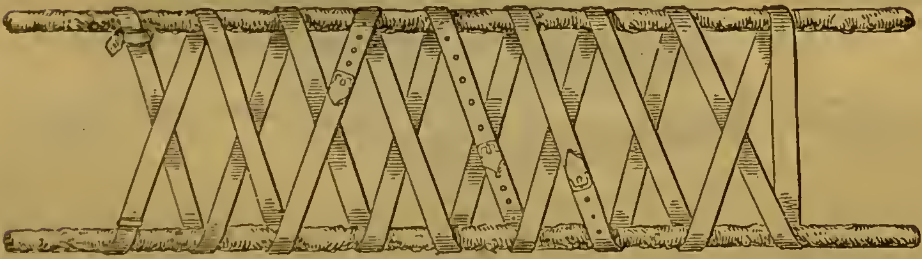

Fig. 5.

General Jackson recommended and adopted occasionally a very simple method of conveying the sick, in his expedition against the Indians—viz., to suspend a bull's hide between two muskets, upon which the patient was carried by two or four men, as the case might require.

Fig. 4 represents a very simple stretcher made with two long poles and two shorter ones laid cross-wise and nailed (or secured by tying), strong cloth, linen, or any other material being stretched across. Boards may be substituted for the cloth, in which case a sack filled with straw, hay, or other soft material must be laid above them. Fig. 5 represents a stretcher composed of two long poles of equal length, with two or three of the men's belts interlaced. Two cross poles would, of course, keep the long ones apart, and make the contrivance more comfortable, but heavy.

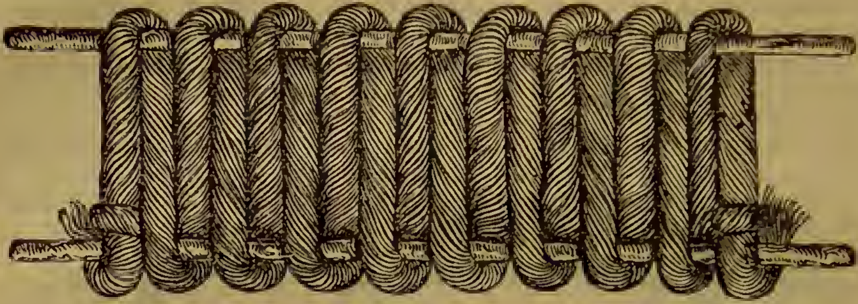

Fig. 6

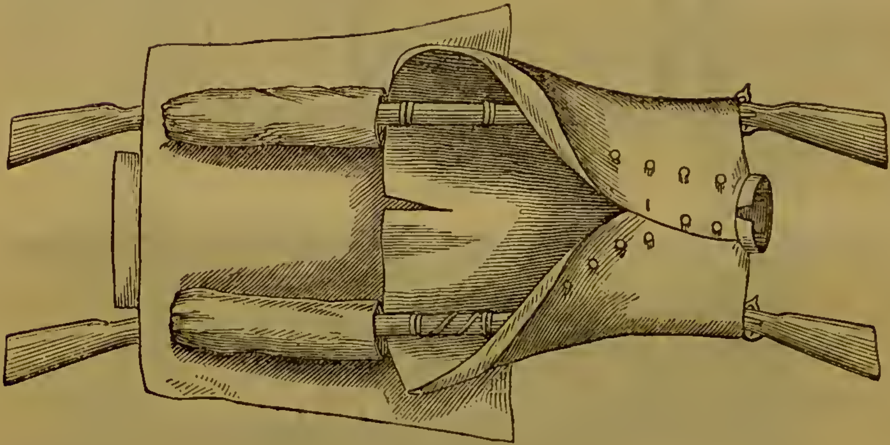

Fig. 7.

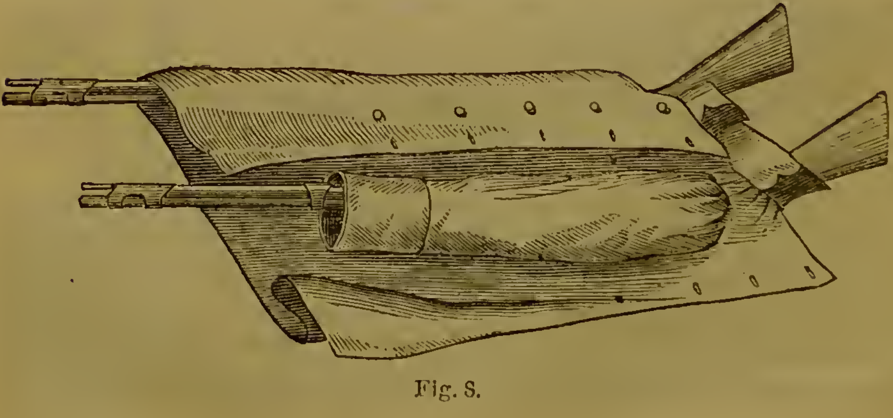

Fig. 8.

Fig. 6 represents a stretcher constructed with a hay or straw rope, which (though troublesome to construct, and requiring experts in the manufacture of the rope), might be found convenient if circumstances admitted of its being made.

Many plans have been devised from time to time for converting men's greatcoats or tunics, and rifles, into temporary means of conveyance, sufficient in an emergency to carry a wounded soldier from an advanced post to the first line of surgical assistance. Fig. 7 represents a stretcher constructed with four rifles and two greatcoats. Two rifles are firmly lashed together by their barrels, so as to take the place of poles. The sleeves of the coats are then turned into the inside of the garments, and

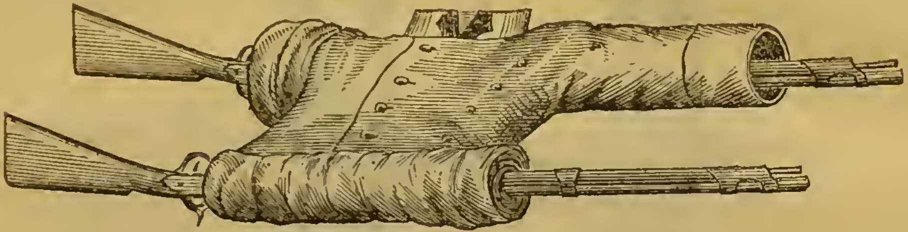

Fig. 9.

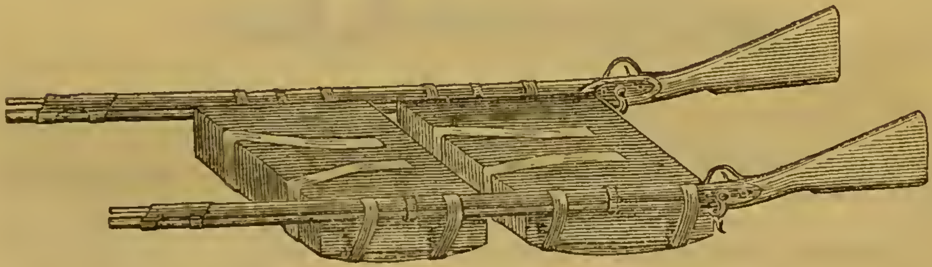

Fig. 10.

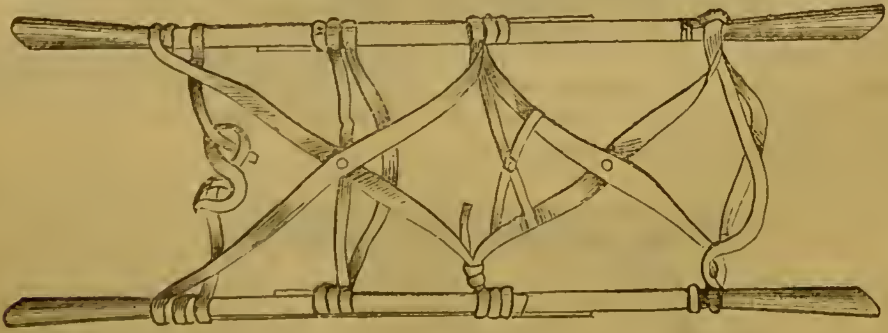

Fig. 11.

the rifles passed through them, after which each coat is buttoned down the front in the usual way. With one tunic or coat, and two rifles, a short stretcher may be constructed, as shown in figs. 8 and 9, which would answer for a wounded soldier unable to walk, but capable of sitting up, his back being placed against front bearer, and his legs hanging down in front of rear bearer.

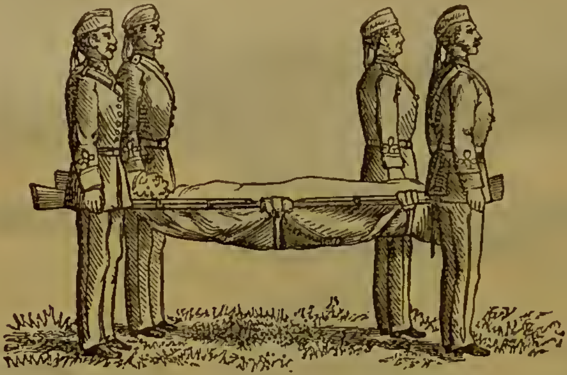

Fig. 12.

Soldiers' knapsacks may be utilised in the formation of stretchers by being fastened with their straps between poles or rifles, as represented in fig. 10.

Figs. 11 and 12 represent an arrangement of four muskets, with valise equipment and straps, devised by Surgeon-Major Sanderson, 30th Regiment.

Dr. Appia suggests that an extempore litter may be made by shirts found in the knapsacks. The poles are to be inserted into the shirt, a number of shirts being placed one above the other. There may be some doubt, he says, as to the solidity or frailty of a litter of this kind, and before placing the patient upon it, it should be tried by a soldier to insure all being in proper order; for nothing can be more distressing than to see a litter break down, or bend under the weight of a wounded and suffering man.

Sailors may in like manner utilise their strong woollen jersies, white smock frocks (jumpers), or serge frocks, by placing them on oars, or boat hooks, the sleeves being turned in.

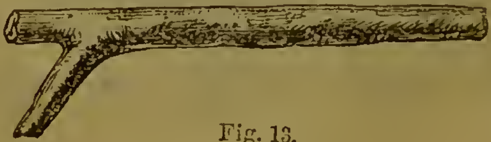

Fig. 13.

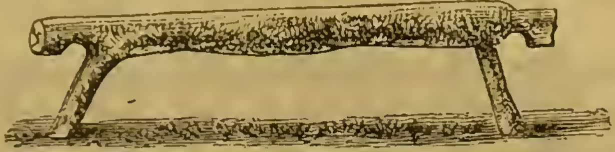

Fig. 14.

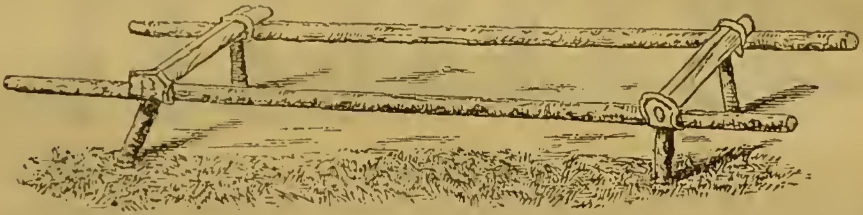

Fig. 15.

Should materials exist for constructing fascines and gabions, excellent litters may be made in the same manner.

Surgeon-Major C. Smith, of the Norwegian Army, has designed, from strong boughs of trees, several most ingenious stretchers, which have the great advantage of being supported by legs—a most important item in the construction of all stretchers. Fig. 13 represents a portion of a bough, having at its side a branch strong enough to serve as a leg; it requires four such pieces to make a stretcher, each being levelled at one end with a hatchet or strong knife, and two of them joined together, as shown in fig. 14. These are then attached to side poles by cords, osiers, or other materials, when the framework of a firm stretcher is constructed (fig. 15), on which is to be placed for its bottom a piece of canvas. He has also constructed stretchers with legs, as represented in figs. 16 and 17, all of which might answer for improvised hospital cots, the handles being shortened or removed.

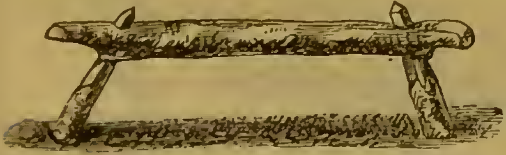

Fig. 16.

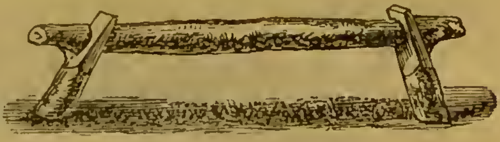

Fig. 17.

Cavalry lances have been recommended for forming the side poles of extemporary stretchers; but they will scarcely bear a weight of 10 stones, are too elastic, and therefore unsafe.

Country Carts.—When sufficient wheeled carriage or transport suited for wounded is not available, country carts may be adapted for the purpose by a few simple arrangements.

If materials are procurable, a stretcher may be constructed with ropes (fig. 18) of straw, hay, telegraph wire, or leather belts, and slung within from the sides of the cart, care being taken that the lashings are well secured, but not too tight or too loose; in the former case, the stretcher would receive the impulse from the body of the cart, and in the latter it would knock against its sides.

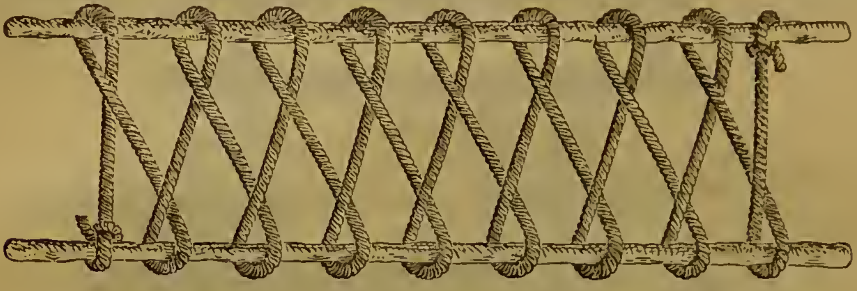

Fig. 18.

Should means for constructing a stretcher not be at hand, the cart may be filled with small branches of trees evenly placed, and over them a thick layer of straw, hay, rushes, ferns, dried leaves, or any soft material on which the sufferer may be laid.

A large quantity of fresh straw evenly laid in a cart will form a moderately comfortable conveyance, on which wounded men may be carried for a considerable distance without any ill effects. In India it is not uncommon to place a dooly on a country cart filled with straw or dried leaves, when bearers are not procurable.

Surgeon-Major Manly, V.C., has described to me an extemporised arrangement for adding to the comfort of the sick when transporting them, which he used in New Zealand. Each drag (a two-wheeled cart) took two wounded. Two hospital bed-cases were filled with fresh ferns and placed in the drag, and two wounded men placed on them. If the wound was of the upper extremity, or through the chest, more ferns were placed under the bed-case so as to raise the front half of it, by which means the man could sit in the recumbent position; if of the lower extremities, the other half of the bed was also raised, so as to elevate the legs and thighs above the body. By these arrangements and proper distribution of sick (that is, when a slightly-wounded man is

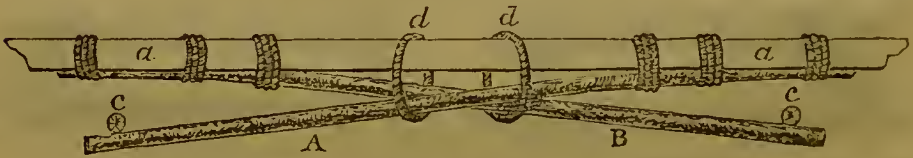

Fig. 19.

placed alongside one badly wounded), marches of 20 and 25 miles were made with comparative comfort.

Surgeon-Major C. Smith has also designed a method for carrying two badly wounded on stretchers in a country hay-waggon. The arrangement is as follows: One end of a rough pole (A, figs. 19 and 20) is lashed to the top side rail (*aa*) of the waggon outside the side bars, to the front, as in fig. 20; another (B) is similarly lashed to the rear; this being done at both sides, cross poles (*cc*) are lashed to the free end of these poles; these cross poles support the stretchers which are lashed to them. In this manner the wounded in travelling have the advantage of the spring of the longitudinal poles; to keep this within limits, bands of osier (*dd*) are placed loosely round them and the top side rail of the waggon.

Railway Hospital Trains.—Railway carriages, vans, or trucks should be made use of when circumstances admit for the more rapid dispersion of the disabled.

Regular railway transport not being available, it may be necessary to convert baggage and store waggons into suitable transport. Mattresses and bed-sacks filled with straw have been laid on the floor of the waggons, but in consequence of the jarring caused by the vibration of the conveyance, they are not considered comfortable. Loose straw has also been tried, but found defective in elasticity, as it becomes rapidly displaced from under the bodies of the patients, accumulating in heaps, easily broken up and matted. When used, the supply should be liberal.

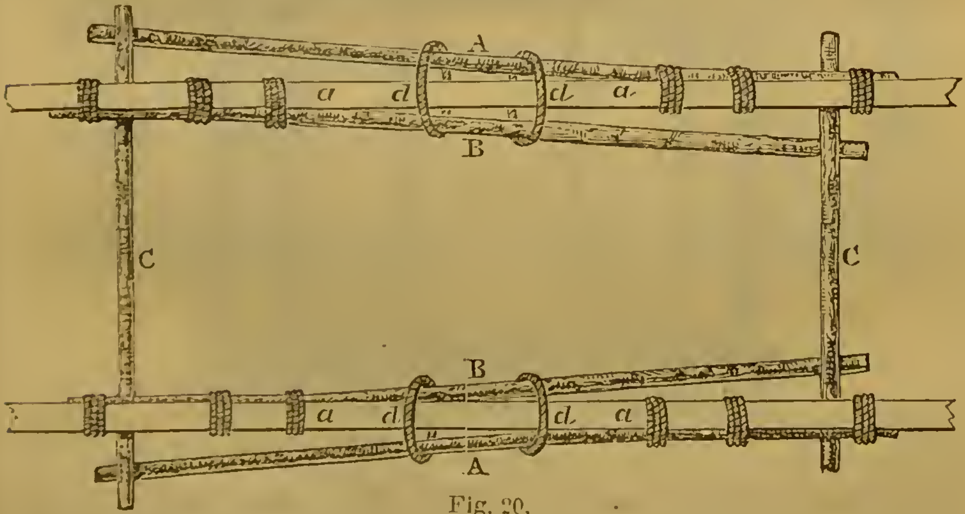

Fig. 20.

Major-General Zavodovsky, of St. Petersburg, has adopted the following plan for preventing all shocks from the motion of trains:—Two cables (AA, fig. 21), an inch in thickness, are suspended across the top of the car, and secured to iron hooks that fasten to iron rings, 2½ inches below the roof of the car. If hooks and rings are not available, the ropes may be passed through four holes bored in the side of the car. To each of the two ropes is attached at three points (*bbb*) a pole of oak, birch, elm, ash, or other springy wood adapted to the width of the car, but at least 8 feet long and 2½ inches thick in the middle, and 1¾ inch at the ends. To the poles thus placed horizontally, there are attached on either side four cords (*cccc*) with knots (*xxxx*), so arranged that they may support on a level the stretchers (DD) on which the wounded men are supposed to be reclining. In order that, when the car is in motion, the stretchers with the patients may not sway backward and forward, and strike against the sides of the car, the lower stretchers are fastened by 1½ inch ropes to three small iron hooks (*z:z*) screwed into the floor of the conveyance.*

Ship's Hammocks, affording most easy and convenient conveyance, may be utilised for the transport of wounded in railway vans or waggons. The method recommended by the author (S. M. Porter) is to erect uprights at either end inside each waggon (the walls of railway waggons are usually not sufficiently strong or thick enough to bear the weight of one or more men suspended in hammocks), which should be secured in a temporary manner to the roof and floor, at such a distance apart that the hammock may be fully stretched when hooked or lashed to them.

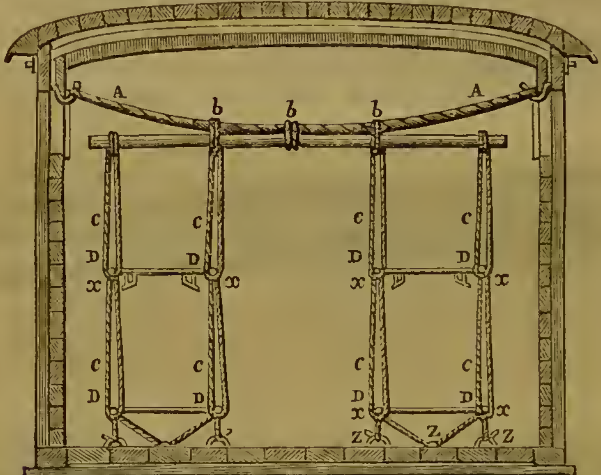

Fig 21.

To prevent the lateral motion or swing which takes place when the waggon is proceeding at speed, that portion of each hammock immediately under the patient's knees should be supported by a stout stick placed horizontally, suspended at either end by cords attached to the roof and again to rings or hooks in the floor.

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* "Report on a Plan for Transporting Wounded Soldiers by Railway." G. A. Otis, 1875.

Four hammocks may thus be suspended in an English "Passengers' railway luggage van.

It might be possible to make use of ship's hammocks for this purpose in the event of transporting sick or wounded from inland to a port of embarkation, where, no doubt, they could be obtained from the shipping. *Horse litters* were used during the American War in 1862, and are well adapted for frontier service; they may be constructed for one or two horses. For the former, one end is supported by a horse or mule, while the other end rests on the ground; with the "two-horse litter" both ends are supported, but as the horses or mules carrying such a contrivance should be well trained, the "one-horse litter" is preferable, and is easily made.

Transport in Mountainous Districts.—In India there are several means for conveying sick or wounded on field service in the hills, such as *dandies* and *jhampans*, but these do not admit of a patient being placed in the recumbent position. The author (S. M. Porter) some years ago designed a conveyance for badly wounded men, which consists of a cot adapted with a hood and cover, and carried with a jhampan frame, as shown in illustration (fig. 22).

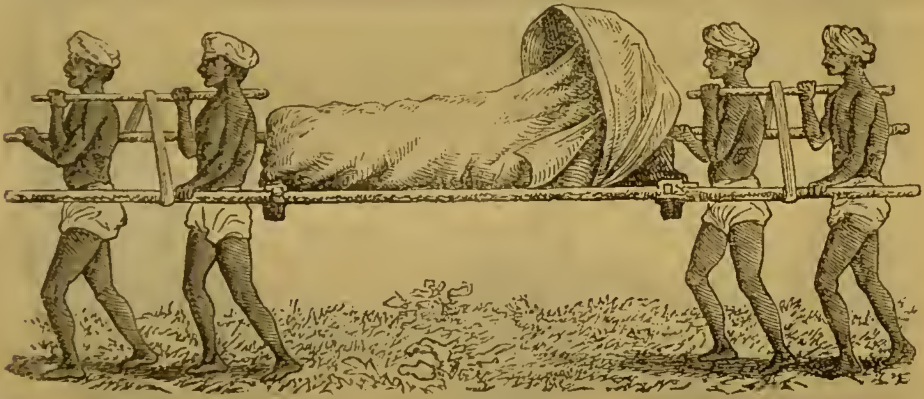

Fig. 22.

This conveyance could be easily improvised from an ordinary bed cot (*charpoy*) and bamboo poles. It has the following advantages, that the recumbent position can be maintained throughout the march; that on the line of march a patient need never be shifted; that the cot answers the purpose of a bed at night; and that a less number of natives is required for its carriage than for any other form of conveyance admitting of a recumbent position. It thus affords all the advantages of a *dhooley.*

Cacolets.—Dr. Appia, who has had great experience with this mode of conveyance, remarks, with reference to the cacolet *with rests*, that it is very rarely of use even in wounds of the trunk, of an arm, or almost of the foot; but that it is impracticable in wounds of the abdomen, in fractures of the thigh, wounds of the knee, and compound fractures of

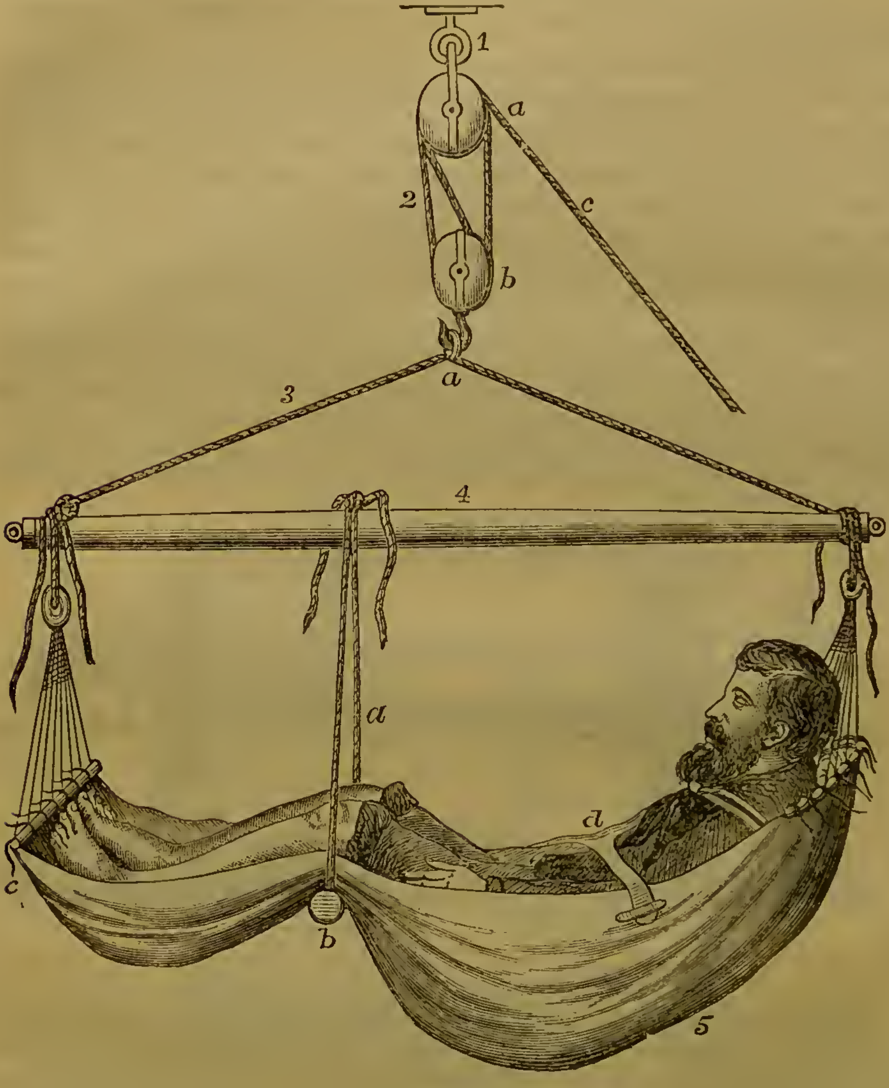

Fig. 23.

Ambulance Lift for Ship or Shore.

References to the Figure.

1. Hook or eye bolt fixed to the beam over the hatchway.
2. A "double-whip," or a purchase with a double block above and a single one below, *a* and *b*; *c*, the hauling part.
3. A "span" with an eye in the middle for the lower hook of the purchase.
4. A pole 4½ feet long, with which the span is connected.
5. An ordinary hammock attached by the head and foot clews to the extremities of the pole, and further sustained by lanyards, *a*, fixed to a ham-piece, *b*, besides

the leg. In cases such as these, the cacolet *bed* has rendered excellent service. In order to prevent the shaking as much as possible, it is desirable to make the patient sit or lie, upon very pliant cushions, and for this purpose he recommends those made of india-rubber, which he has frequently made use of.

For the embarking or disembarking of sick or wounded, where stretcher conveyance is not available or cannot be used, Dr. J. D. Macdonald, F.R.S., R.N., has designed an "ambulance lift for ship or shore" (fig. 23); it appears to be admirably adapted for the purpose. The ham-piece (5 *b*) is well placed, and would give great support where there are injuries of the lower extremities.

SERVICE IN THE FIELD.

In making preparations for the field, compactness should be the first consideration, the object in view being to dispense with luxuries as far as possible, and carry on the duties with the least amount of encumbrance, or, in other words, to have as little impedimenta as circumstances will permit.

It is quite surprising how, on active service, an ingenious surgeon will take advantage of the most trifling circumstance, and how soon he discovers he can do without many things which in time of peace he would have looked upon as indispensable.

Accompanying Troops into Action.—The surgeon should not be hampered with too many things about his own person. What I[*] have generally found most convenient are as follows:—Pocket-case of instruments well furnished with silk, needles, &c., carried in the pouch of the cross-belt; and in a soldier's haversack or small black leather bag, a small supply of lint, two or three bandages, adhesive plaster (Leslie's tape plaister recommended), tourniquet, a flask of wine or brandy, a hypodermic injection syringe, with a small phial containing 2 or 3 drachms of solution of morphia.[†] A clasp knife will be found most useful for cutting off clothes and shaping splints, &c. If mounted, the surgeon can, of course, carry many necessaries in his holster wallets. With these he will be in a position to commence affording relief to any wounded.

Medical assistance in the field[‡] is thus provided by the regulations. A medical officer is attached to each regiment, battery of Royal Artillery, and company of Royal Engineers. With a regiment he is provided with

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which a strengthening footpiece, *c*, is retained in its place by the foot clews of the hammock, and greater security is given to the patient by the strap and toggle, *d*, holding the sides of the hammock together. The ham-piece, 5 *b*, is tightly secured to the hammock to prevent displacement.

[*] Porter.

[†] Morphia in solution is liable to spontaneous change, and is uncertain in its strength if laid up for any time. To obviate this, M. Vidal adds to the solution a quantity of chloral equivalent to twice the weight of the morphia it contains.—"New Remedies," Jan. 1870.

[‡] Abbreviations used in the text—P.M.O., Principal Medical Officer; O.S.D., Ordnance Store Department,

one pair of field medical and surgical panniers, one field companion with water bottle complete, one surgical haversack, one circular tent; but, if with a smaller unit, he is supplied only with a field companion with water bottle and one surgical haversack. This equipment the medical officer draws from the army medical stores previous to embarkation, and on taking the field, it is carried for him in the regimental transport. He replenishes his stores from the nearest field hospital. The regimental quarter-master draws the field stretchers in the proportion of one for each company, and conveys them in the regimental transport. The medical officer is required to enter his transactions in Army Book, 39, and beyond this, to furnish no returns or reports unless specially called for. His duty is to see in the first instance all men reporting sick, to afford temporary aid to sick and wounded in camp, on line of march, and in action, to prevent malingering or accumulation of sick in front. When an action is expected, he should obtain the services of the trained regimental stretcher bearers in the proportion of two per company, place a corporal in charge of the field panniers, and then afford such temporary aid to the wounded as may be within his power, but neither he nor his bearers should on any account lose touch of their corps.

First line of medical assistance is formed by the Bearer Companies. A bearer company consists of three medical officers, one quarter-master, and 66 non-commissioned officers and men of the Medical Staff Corps, and from the reserve of the Medical Staff Corps or Militia Reserve. It is commanded by a medical officer, who draws the necessary stores and equipment from the Royal Arsenal, Woolwich; he is responsible to the P.M.O. at the base for the arms, accoutrements, clothing, and necessaries of the men, and will account to the O.S.D. for the equipment and stores of the company in Field Equipment Ledger Army Book, 248. It is most important that the *personnel* and *matériel*, and, if possible, the transport of a bearer company should embark together in the same vessel, and sail with the Division to which it is attached. The transport of a bearer company whether wheeled or packed, is furnished by the Commissariat and Transport Corps, and while attached to the bearer company is under the command of the medical officer, and is not to be moved unless by order of the General Officer Commanding the Army Corps. Two companies are provided for a Division, and eight for an Army Corps, so that each company will be attached to a Brigade. They are to be associated with and encamped near the field hospitals, so that they can afford every assistance to the sick and wounded, and furnish the necessary guards, but their organisation is to be kept quite distinct. When an action is expected, the medical officer under direction of the P.M.O. of the Division will arrange suitable "collecting rendezvous" and "dressing stations;" the former should, if possible, be under shelter, but as close as is convenient to the fighting line, and the latter out of fire.

At the Collecting Rendezvous, which should be indicated by a red flag, the sergeant-major should have sufficient reserve of bandages and first dressings to replenish the haversacks of the bearers, and here the ambulance waggons will assemble. Two sections of bearers with stretchers and haversacks will now be sent out to succour and collect the wounded, bringing them to this rendezvous and placing them in waggons, but they will return with their stretchers to the field and must not pass in rear of the collecting station. As the ambulance waggons are loaded, they should be sent off under charge of a non-commissioned officer or private of the Medical Staff Corps to the dressing station, and—as soon as they are unladened, they should return to the collecting station, and on no account go in rear of the dressing station.

At the Dressing Station, which should be marked by two red flags, or by two red lanterns at night, the senior medical officer with another surgeon and the quarter-master will be assembled with the surgical equipment, stores, and water carts. If any building is available full use should be made of it, if not the tent must be pitched; beef tea, &c., should be got ready, and everything put in readiness that can afford aid to the wounded coming in, and to help during the pressure of work. Medical officers should be borrowed from the nearest field hospital. After the wounded are dressed, and a tally ticket attached to each man's clothes specifying the regiment, number, rank, and name, with the nature of the injury, the treatment, &c., they will be placed in the ambulance waggons of the second line and taken to the field hospitals under direction of the quarter-master. The amount of attention that should be paid to the wounded at the dressing station would differ very materially according to the distance of the field hospitals; if the latter were close at hand, little or no interference would be required, but if considerable distance has to be traversed, and many hours have to elapse before the field hospital could be reached, surgical operations of all kinds might have to be performed to bring them within the range of primary operations, that is within the first thirty hours, after that the operations would have to be classed as intermediate, and this is the period no surgeon would willingly choose. The quarter-master sergeant with the cooks, batmen, and baggage should be placed a little in rear of the dressing station, and arrange so as to have a meal ready for the men of the company after the action is over. After the engagement a close search should be made for any wounded men, or men apparently dead, and lanterns for searching in the dark form part of the equipment.

The arms, ammunition, and accoutrements of a wounded man are always to be picked up and carried with him to the dressing station and field hospital, but great care should be taken to see that the rifle is not loaded before it is carried away.

The second line of medical assistance consists of the Field Hospitals. Each hospital is a unit for 100 patients, and has as its *personnel* four medical officers, one quarter-master, and forty-five non-commissioned officers and men of the Medical Staff Corps. On its formation, the quarter-master, upon requisition, draws the necessary stores and equipment from the Royal Arsenal, Woolwich, and the medical officer is responsible for the equipment of the *personnel* and accounting officer for the equipment and stores of the hospital. It is most important that the *personnel* and *matériel* should embark together. The transport, whilst attached, is under the command of the medical officer, and is not to be taken away unless under the authority of the General Officer Commanding the Army Corps. Four field hospitals are supplied to each Division, one is attached to each Brigade, and two in reserve for Division Corps troops if necessary. The number for an Army Corps is fourteen, including two attached to the Cavalry Brigade and Corps troops. The regulations lay down that all will be fully equipped, and each supplied with transport, so as to be independently movable and available for any service. On the line of march they follow the bearer companies, the men of which, on request, will assist in pitching the hospital tents when a camp is formed. Each hospital is so arranged as to be capable of being divided into half hospitals for 50 patients. They are non-dieted, and all patients bring with them their kits, arms, and accoutrements, which have to be entered in detail in the Pack-store Book, A.F., 182. It is most important that every man's name should be at once entered in the Admission and Discharge Book, so that there can be no doubt as to whether any particular man has passed through the hospital or not. When it is decided to send men towards the Base, a medical certificate and a nominal roll in duplicate should in all cases be prepared to accompany the sick, who should be passed as soon as possible to the rear, unless in the case of men likely to be fit for duty in a few days, or those who would suffer by removal, but before an action all cases that can be removed should be sent away.

When a field hospital of a Division cannot be moved on account of the sick and wounded, want of transport, &c., it will cease to belong to the Division, and will come under the P.M.O. of the lines of communication, and its place will be taken by one of the reserve hospitals. The points to be attended to in selecting a site are that it should be as near the first line of assistance as possible; that there is a practicable road for the waggons from the front; and that there is a good supply of water at hand. Advantage, too, should always be taken of any suitable buildings. Hospital clothing is not provided, and if any clothing, underclothing, or necessaries be absolutely required, they are to be obtained by requisition on the depôt of clothing under the General Officer Commanding the lines of communication. All washing of clothing is done by the *personnel* of the hospital, the soap and soda being obtained as usual by requisition from the Commissariat. The field hospitals replenish, from their reserve panniers, the wants of the bearer companies and regimental medical officers, and will replenish their own stock from the advanced depôt of medical stores.

Advanced Depôt of Medical Stores.—This depôt is established on the lines of communication as near to the field hospitals as possible, and will move forward as the troops advance. The medical officer in charge will obtain his supplies from the depôt of medical stores at the Base. He should keep his supplies packed in handy boxes, and take care to avoid any undue accumulation which would hamper his forward movements. The only book he is required to keep is the Register of Medical Stores Army Book, 168.

The third line of medical assistance is constituted by the Stationary Hospitals on the lines of communication. They are supplied with a modified equipment with a view to their being readily moved when necessary. They are under the General Officer Commanding and P.M.O. of lines of communication, and are to be dieted if possible; they are not supplied with transport; the number would of course vary with the distance from the Base. In choosing sites for the stationary hospitals, due attention should be paid to the character and elevation of the country, the nature of the soil, the water supply, and drainage, they should be easy of access, near roads or railways, and all advantage taken of buildings that may be suitable, if none are suitable hospital marquees will be furnished from the Base. Separate accommodation is always to be provided for sick and wounded officers. All sick transport from the field hospitals in front along the lines of communication is to be provided by the General Officer Commanding lines of communication, and when parties of sick and wounded are about to be sent from the field hospitals, the Surgeon-General of the Army Corps must warn the P.M.O. of lines of communication, who will then make provision for medical inspection, attendance, and supplies on the road. With each party of sick and wounded proceeding towards the Base a non-commissioned officer of the Medical Staff Corps will take charge of the pack-store lists, kits, arms, and accoutrements of the men, and should a man be left in a hospital on the line of communication, his pack-store list, kit, arms, and accoutrements are to be left with him. But if a man dies on his journey to the Base, his effects are to be taken on and handed over to the Officer Commanding the military depôt at the Base. On arrival of a sick convoy at the Base, the medical certificates and nominal rolls are to be handed over to the P.M.O., the kits are to accompany the men to hospital, but the arms, ammunition, and accoutrements are to be handed over to the Officer Commanding the military depôt.

A General Hospital at the Base, with military depôt attached, is to be formed at the Base for 500 patients, if inexpedient to form it on shore, its place may be taken by a hospital ship. It is to be organised and administered in a similar manner to such hospitals in peace. Separate accommodation is to be furnished for officers.

A depôt of military and surgical stores at the Base will be established for the supply of hospitals and ships. The medical officer in charge will obtain his fresh supplies by requisition on the Director-General at home.

After an Engagement with the Enemy.—An engagement having taken place, the surgeon is called upon to attend the wounded; he will have many points to consider as each man comes before him, and these must be rapidly turned over in his mind, and as quickly acted upon. There may be violent hæmorrhage, extreme constitutional alarm, or what is generally known as "shock," pain, insensibility, fracture, laceration of soft parts, or internal injury of some kind.

Surrounded by a great number of wounded, the surgeon may feel puzzled to know what condition he should relief first.

Wounded to be first relieved.—In all probability he will have to afford assistance as he meets the wounded, or as they are brought to him; but should he be in a position to make a selection, those suffering from hæmorrhage should be his first consideration, while those otherwise wounded should have warm drinks or stimulants administered, and with consolation and a few kind words they will be in a more comfortable position and better able to bear the pain of having their wounds dressed when their turn comes.

Hæmorrhage.—The expedients for arresting hæmorrhage are considered under the subject "Hæmorrhage."

Shock.—The constitutional disturbance which takes place on a man being wounded is described as shock. This differs in severity in different subjects, being influenced by moral character, intelligence, state of health, and nature of wound. It has also been stated that conical bullets from a rifle cause greater shock than round. As a rule, the greater the injury the more intensified the shock. At the same time there are examples of very severe wounds, and but little shock, and *vice versâ.* Mr. Guthrie mentions a case of a soldier at Talavera, who was struck on the head by a 12-pound shot, which drove some bone into, and some brain out of his head. He was walking about, complaining but little, immediately after the accident, although he died subsequently.

Sir T. Longmore writes—"Shock is more or less persistent, according to the nature and extent of injury or constitutional peculiarities; as a general rule, the graver the injury the greater and more persistent is the amount of shock. The practical experience of every army surgeon teaches him that where a bullet has entered the body, though its course be not otherwise indicated, the continuance of severe shock is a sufficient evidence that some organ essential to life has been implicated in the injury. Out of 100 consecutive cases of fatal gun-shot injuries registered in the Crimea, shock is entered as the direct cause in twenty, the fatal termination occurring in all but two cases in the course of the day on which the injury was inflicted. In eight the injury was due to a bullet, and in all of these, the projectile had penetrated the cavity of the abdomen."

Erichsen writes [*]—"Shock is due to the impression produced in the nervous centres by the violent afferent impulse caused by the injury to the peripheral nerves during the accident. The exhaustion of the nervous centres thus induced is shown by the general state of muscular relaxation, the loss of tone throughout the vascular system, the feeble action of the heart, and the state of semi-unconsciousness into which the patient is thrown." The temperature falls to about 97°, but may fall as much as 6°. "The condition of shock lasts for a variable period, its duration depending on the severity and seat of injury, on the nervous susceptibility of the patient, and on the state of his mind at the time."

[†] My experience is, that all wounded suffer to a greater or lesser extent from shock, which manifests itself in feebleness of pulse, cold perspiration, change of colour, and disquietude of mind; the more aggravated form, where large joints are injured, long bones fractured or cavities opened, being fainting, mental agony, loss of reason, convulsions, hiccup, vomiting, irregular chills, sense of weight, collapse,—all of which are most unfavourable symptoms, and their continuance sufficient to cause great alarm.

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[*] *Science and Art of Surgery*, vol. i., p. 287.

[†] Porter.

The treatment consists in administering consolation or encouragement, cordials, beef-tea, wine, or brandy. In severe cases the patient should be placed in the recumbent posture, warm bottles to the feet, friction to the surface of the skin, a turpentine enema, the subcutaneous injection of ether in 10 minim doses, and the administration of opium internally.

The pain of a gun-shot wound is sometimes excruciating, especially when a large nerve has been wounded, or the weather is very cold. The use of morphia in solution, given in the form of a hypodermic injection, has been found to afford such speedy relief, to be so convenient of administration, and so portable, that it is now generally used in warfare.

First Dressings.—Urgent cases having been attended to, the surgeon will proceed to put up fractures, which will require much skill and care. He can then afford aid to the more lightly wounded, who, in all probability, will require little more than a piece of antiseptic lint, cotton-wadding, jute, or charpie, secured by a bandage or roller. It may be well to observe, that any dressing had better be omitted rather than have it applied with dirty fingers or dirty water.

The best form of first dressing has been the subject of much discussion. It seems to be now agreed that the best form of dressing for first use in the field is some dry absorbent antiseptic material, but the great difficulty consists in how it is to be carried. Soldiers have few pockets and many things to carry; it seems desirable, therefore, that the packet should be fastened inside the flap of the coat, or elsewhere, and not be entrusted to the man to carry it in his pocket. Probably the best appliance would be a fold of salicylic or boric lint, or lint that had been previously soaked in a 1–1000 solution of mercuric chloride, quantities of which might be prepared in anticipation of the action; a fold of one of these lints together with a bandage, triangular or other, should be folded into a small packet, wrapped up in some waterproof cloth, and fastened in the man's coat under the left flap as a convenient position. A German military surgeon has lately advocated cloth of the substance of flannel as the best material for the first dressing, but it really does not matter so long as the material is light, antiseptic, and absorbent, as the two great objects are, first to cover up the wound from the sight of the soldier; and secondly, to keep out extraneous and septic matter.

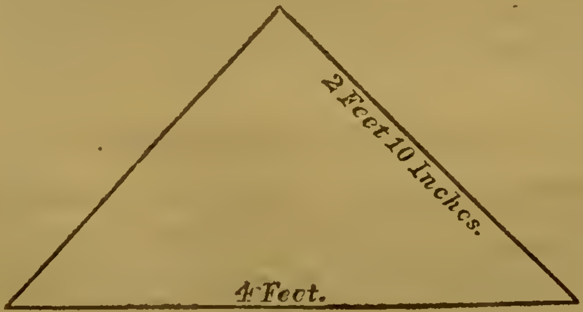

Fig. 24

Sir T. Longmore designed a field dressing for the troops engaged in Egypt during the last expedition, the contents of which are detailed in the appendix.

Bandages.—*The insufficient supply of bandages* is generally much felt after engagements, as it is impossible for the surgeon or his attendants to have at hand a number equal to the necessity of the occasion; and though a supply may have been provided, they will very likely not be forthcoming when required.

Esmarch Bandage.—Professor Esmarch has designed a triangular bandage (fig. 24), which can be applied in thirty-two different ways. It measures 4 feet at its base by 2 feet 10 inches. It can be folded flat, and therefore takes up but little space. The bandage is enclosed in a waterproof envelope, which protects it, and no doubt would be found useful as part of the dressing.

At the Brussels Exhibition, 1876, he exhibited a "first dressing," composed of one triangular bandage with a safety pin; four small packets of 10 per cent. salicylised cotton charpie enclosed in varnished paper; one piece of salicylised gauze bandage, about 4½ inches broad by 1 yard long; and four common pins. The whole were made up into a small packet, and wrapped in waxed paper.

Lights.—It frequently happens in service that the surgeon may not be provided at night with lamps or candles for dressing wounds. Surgeon-Major Porter improvised a lamp from the soldier's oil-bottle by simply placing a piece of lint in it, and a pin cross-wise, so as to prevent the lint from slipping in. By means of this lamp (fig. 25) he has, in a darkened room, been able to ligature a carotid or femoral artery. For improvising a lamp and reflector an apparatus with a candle and spoon, as shown in fig. 26, might be constructed.

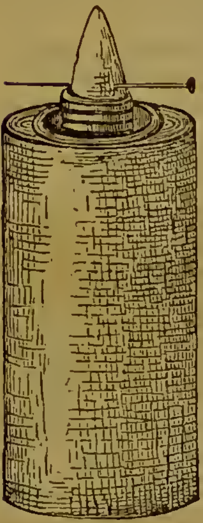

Fig. 25.

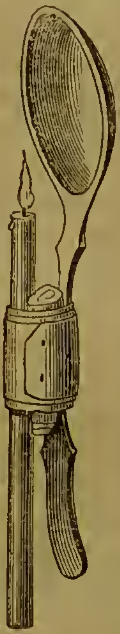

Fig. 26.

GUN-SHOT FRACTURES.

Gun-shot Fractures, especially of the lower extremities, are always sources of great anxiety on the field of battle, as the sufferer must, as a rule, undergo transport, and unless the limb or limbs are securely "put up," even in a temporary manner, the consequences will be most serious, often rendering slight injuries severe and complicated.

Extemporary Appliances.—It is not always possible to have at hand special splints, plaster of Paris, or any of the numerous contrivances for securing fractures; the surgeon will, in consequence, frequently be

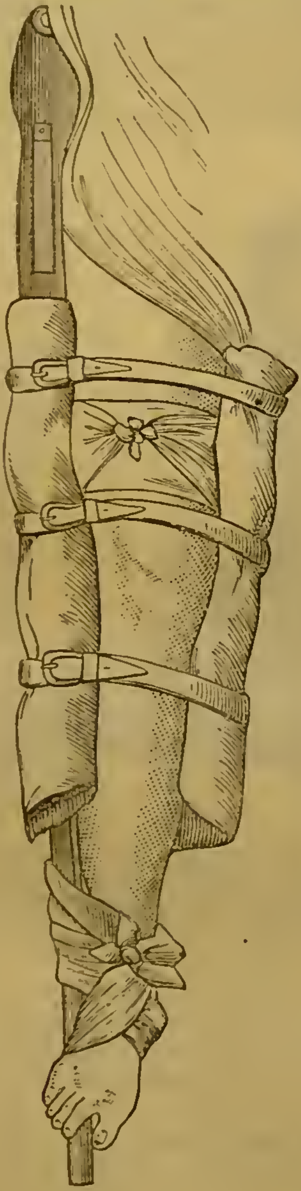

Fig. 27.

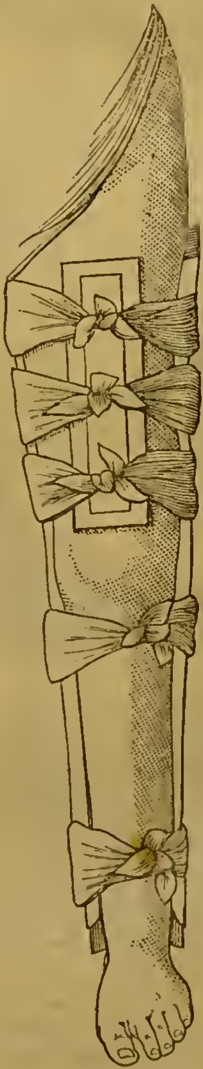

Fig. 28.

obliged to make use of such expedients as circumstances will admit of, or, in other words, improvise splints from materials generally available on the field of battle. For this purpose, in a case of *fracture of the thigh*, a rifle may be placed along the outside of the limb (fig. 27), extending from the axilla to the foot. It should be secured by a bandage round the trunk, and by another round the foot and ankle; a soldier's greatcoat or cape should then be folded, so as to partially surround the limb and the rifle, the whole being secured by means of the straps of the greatcoat, bandages, or anything suited for the purpose. The butt end of the rifle should be placed in the axilla.

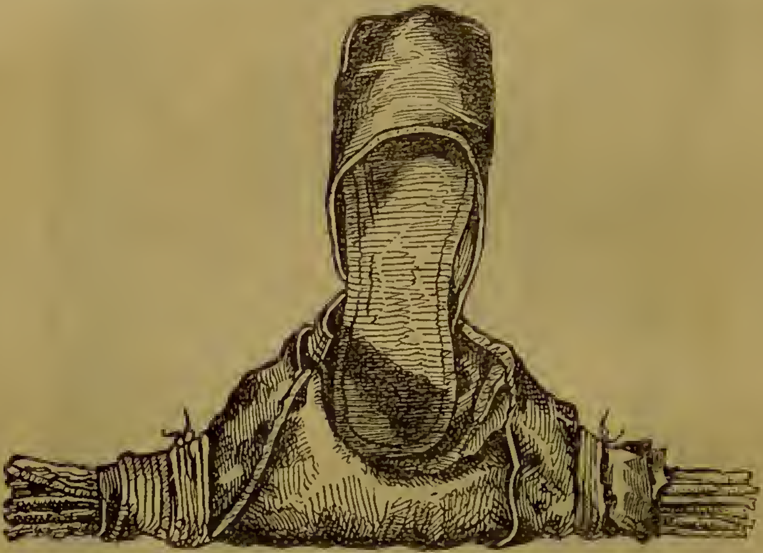

Fig. 29.

Another plan for putting up a fractured thigh is with two long splints, one reaching from the hip to the heel, and the other from the perineum to the heel, a third short one being placed in front, and the whole secured by straps, handkerchiefs, or bandages (fig. 28). Both feet should be tied together.

Esmarch, in putting up fractures of the thigh on the field, makes use of the soldier's long boot (all the troops in the German army wear the Wellington boot), to which he attaches his means of extension, and gives support to the leg. He cuts the boot down the front as far as the instep; the sole of the boot is then perforated in two places in front of the heel, through which the extension cord or bandage is passed, the soft *upper* is then rolled backwards on a stick or short sword (fig. 29) and secured, the foot is then placed in the boot and secured with an ordinary bandage. This having been done, and extension made to the end of the stretcher, it will be found that the sword or stick on which the *upper* is rolled will rest on the side poles of the stretcher, and give great support to the leg. Counter extension is made by a perineal bandage (piece of cloth or waistbelt) secured to the upper cross-bar of stretcher, a strong elastic ring intervening between the knot and perineal bandage and cross-bar of stretcher. The fractured thigh bone is to be surrounded with a scored splint and secured with two or three turns of a bandage.

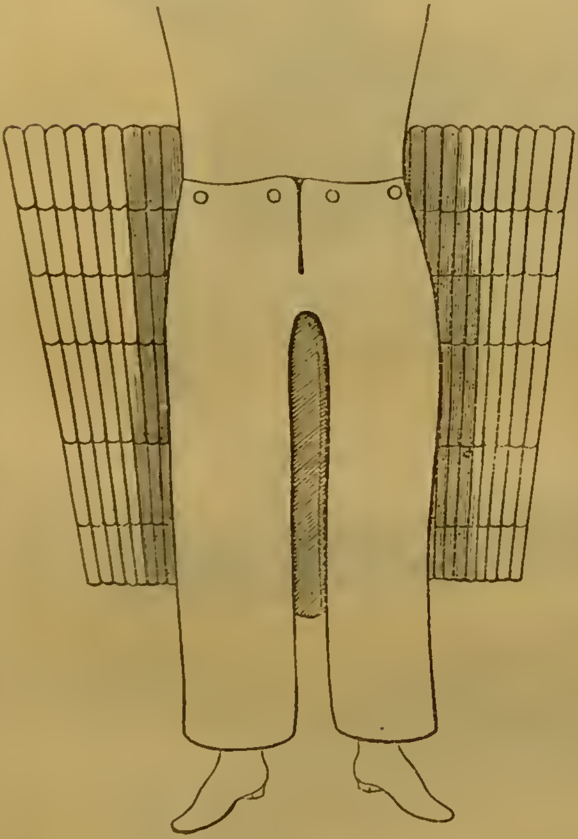

Fig. 30.

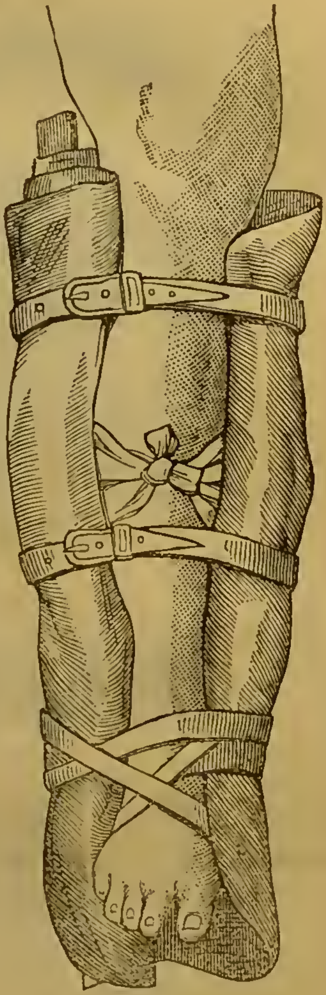

Fig. 31.

Straw Mats.—Dr. Port suggests the use of straw mats for transporting patients with fracture of the thigh. He directs that the mat should be spread out on the ground, and the injured man laid on it in such a manner that the upper edge of the mat will project a little above the crests of the hip bones; a chaff or sand bag is to be placed between the thighs, the sides of the mat wrapped round the pelvis and thighs, and the whole secured to the injured man's body with three cords (fig. 30).

For fractures of the leg, the following extemporary splints may be constructed with very little trouble :—Fig. 31 is intended to represent a fracture of the leg secured with a splint placed along the outside of the limb, and the whole rolled in a greatcoat or cape fastened by straps or pieces of bandage.

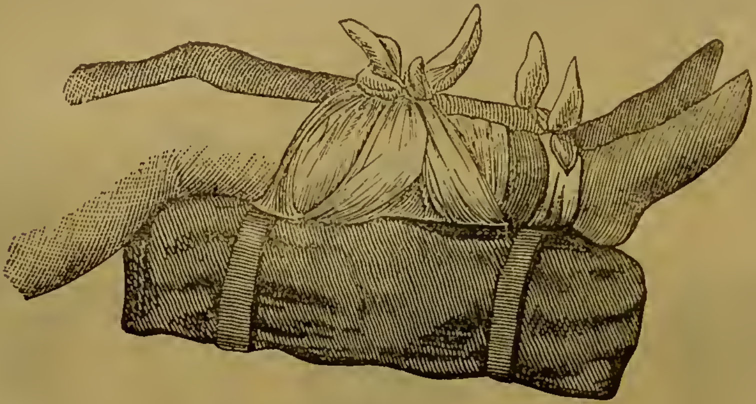

Fig. 32.

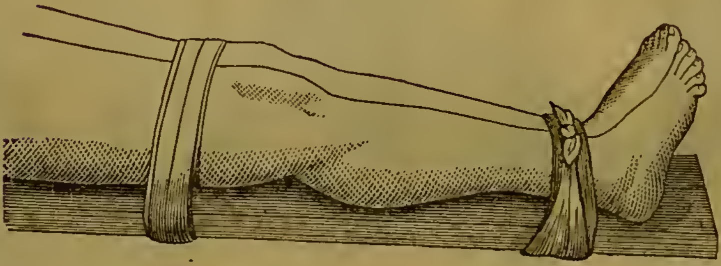

Fig. 33.

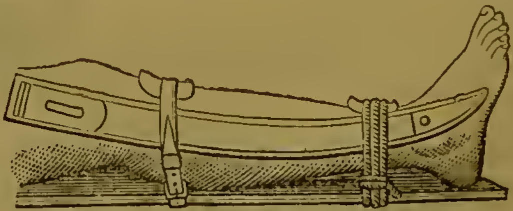

Fig. 34.

Figs. 32 and 33 speak for themselves, In one the legs are tied together at the ankles, and placed on a soldier's knapsack, and in the other the legs are also tied together, but they are placed on a board. In securing limbs in such positions, some soft material should be placed underneath them and in between, so as to fill up spaces and make the parts comfortable. If nothing better can be found, hay or straw will answer.

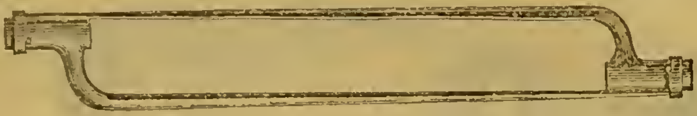

Fig 35.

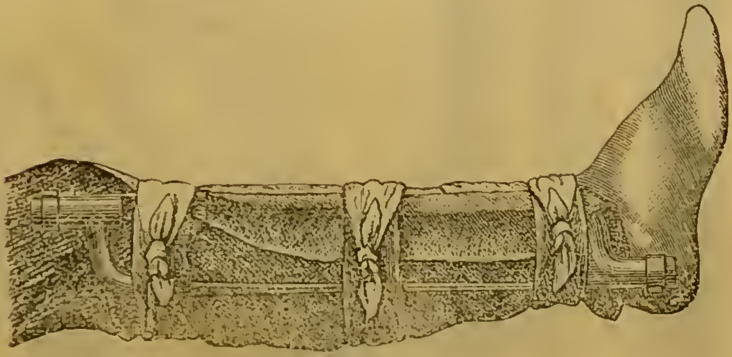

Fig. 36.

A fractured leg may easily be put up with the scabbard of a sword and a board, as represented in fig. 34, or with two bayonets, as in figs. 35 and 36.

A roll of straw makes a capital temporary splint, placed along the outside of the limbs, as shown in fig. 37.

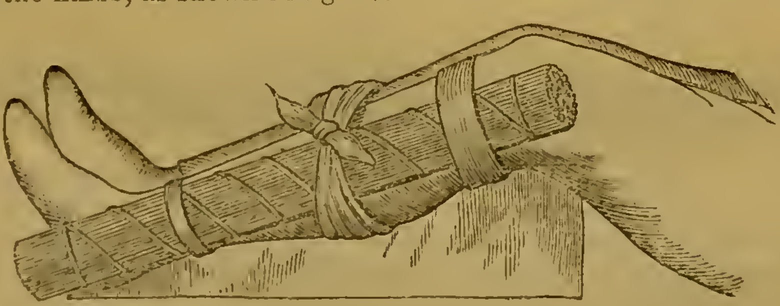

Fig. 37.

When a piece of cloth and two rolls of straw are available, a most comfortable splint may be constructed by placing the limb in the centre of the cloth, and rolling bundles of straw of equal thickness (and the length of the limb) until they come in contact with the fractured member (fig. 38), *Fractures of the arm* may be "put up" with very thin bundles of straw lined with cotton wool or wadding, or they may be enveloped in straw, in which case it is of course necessary to have a soft lining.

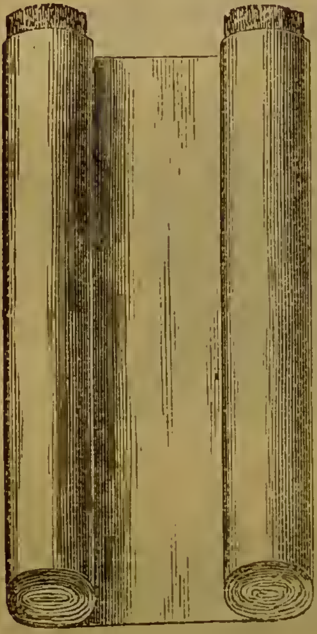

Fig. 38.

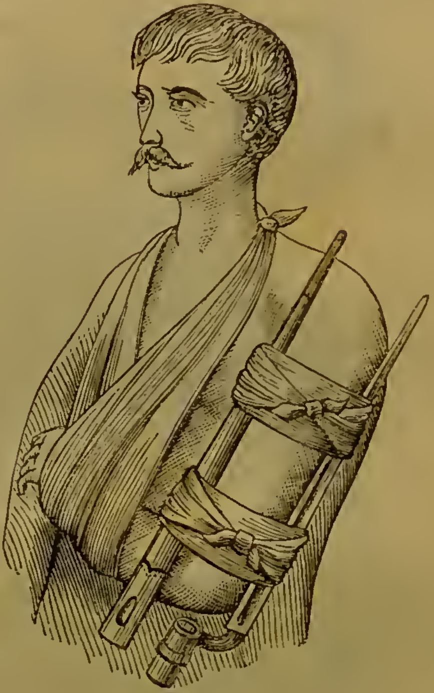

Fig. 39.

Fig. 39 represents a fracture of the upper arm "put up" with a bayonet and its scabbard, which, if nothing better can be found, will prevent the limb from being further damaged in transport.

Should thin pieces of board be available, such as the lining boards of a soldier's knapsack, they may be applied as represented in fig. 40. The forearm being flexed, one splint is placed on the inside of the arm, reaching from the axilla to the inner condyle, a second long splint is placed on the outside of the arm, reaching from the acromion to the external condyle, and a third may be placed on the front and a fourth behind; these may be secured by straps or bandages. The forearm should be supported with a sling.

Fractures of the lower end of humerus are best secured with an inside rectangular splint, the straight splint not giving sufficient support.

Fractures of the forearm may be put up with two light splints, one placed in front and the other behind, and as a temporary contrivance the splints may extend beyond the fingers, so as to give perfect support to the hand and wrist during transport. On arrival at a permanent

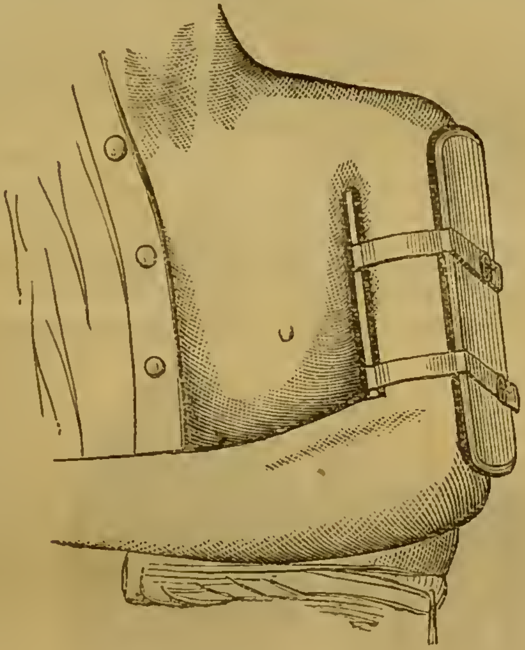

Fig 40.

hospital, or any place where proper splints are procurable, the temporary ones should be replaced by such as are in use and recommended for particular fractures.

SPLINTS.

It has always been a special point in preparing surgical appliances for war to provide splints of materials which will be sufficiently strong to

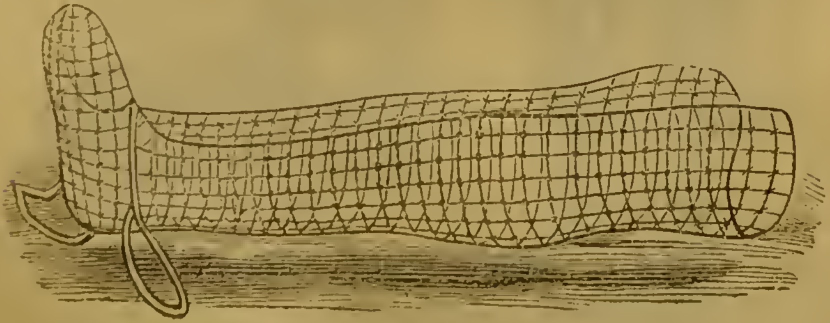

Fig. 41.

support the largest bones when fractured or shattered, and at the same time be light, easily carried, and capable of being applied with facility.

The old-fashioned *wooden scored splints* were at one time much used, but they were liable to be rendered unserviceable by exposure to wet or from the moisture of wounds, and have consequently fallen into disfavour; they are, however, in the opinion of the writer, the most valuable and useful splint which a surgeon can take into the field with him, being light and easily adapted to all regions.

Wire or Trough Splints.—The French have introduced splints made of wire, which are very strong, but somewhat cumbersome; they are formed to the shape of the limbs for which they are intended, those for large limbs being composed of a stronger description of wire than those for smaller, and having the general appearance of splint represented in fig. 41, which is intended for the leg.

Wooden and Metal Gauze Splints.—The German army surgeons are provided with strips of thin metal gauze, and thin pieces of wood, but little thicker that veneer, which substances are very light, easily carried, and take up small space in the hospital knapsack.

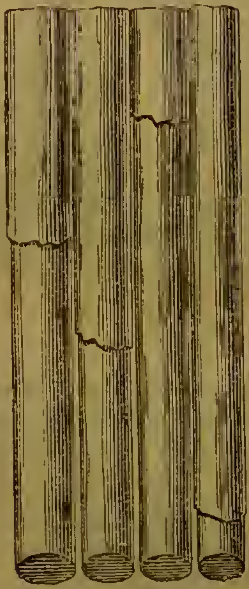

Fig. 42.

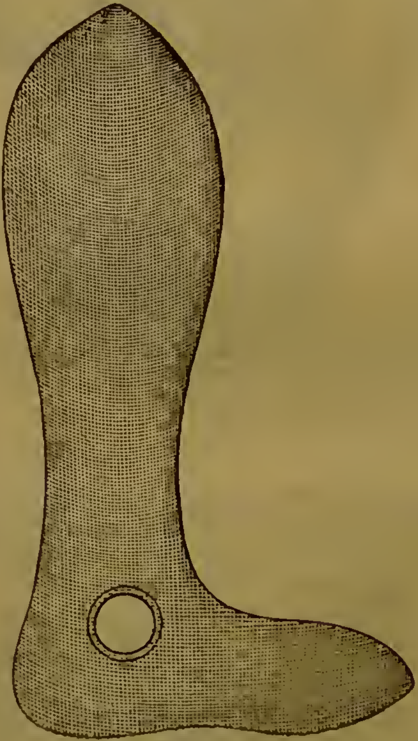

Fig. 43.

Duncan Splint.—Duncan has designed a splint known as the "*rattan* *splint:*" it is composed of cane or small rattan, strung as it were together and cut to certain lengths; each end is covered with a cap of cloth to prevent splitting or the rough ends irritating. They are very light, but rather bulky, presenting the appearance, without caps, as shown in fig. 42.

A modification of this splint has been made by covering the cane with canvas and attaching three straps and buckles, or as many as may be considered necessary for the size of the splint; this makes the splint more bulky than Duncan's.

Iron-wire Gauze Splints (fig. 43), familiar to all surgeons, form most convenient appliances, but are heavy and apt to rust when exposed to moisture.

Wyatt's Splint.—Surgeon-Major Wyatt has designed a splint for field purposes which in appearance resembles an ornamental cover for a flower-

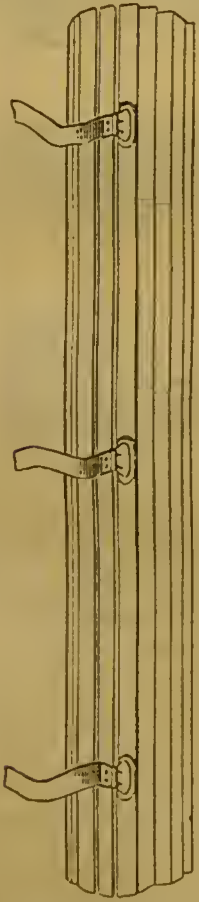

Fig. 44.—Wyatt's Splint folded up.

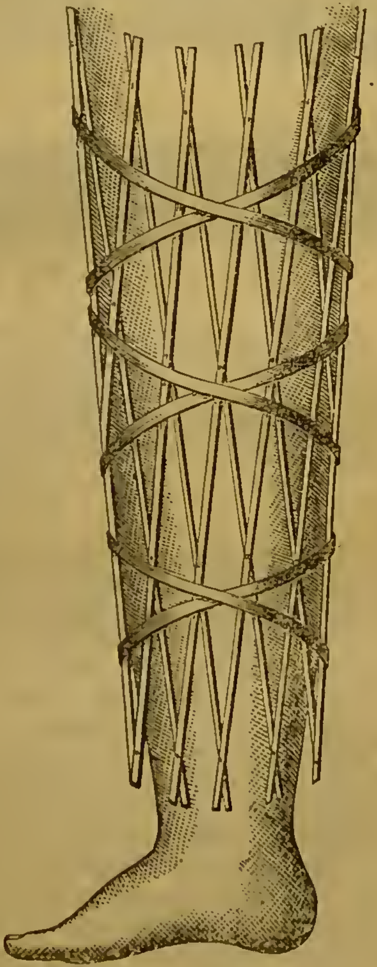

Fig. 45.

pot. It is capable of expanding to a very great extent, and therefore can be made use of for any limb, no matter how large its circumference may be. He proposes enveloping the fractured limb with it, filling spaces and irregularities with carded oakum, and securing the whole with three straps and buckles (figs. 44 and 45).

Thin sheets of perforated zinc or tin, guttapercha, leather, cane, whalebone, felt, and various other materials, have been proposed, so important and necessary is it that some kind of splint should reach the field of battle and be ready for immediate application.

Extemporised Splints.—Besides the extemporised splints already mentioned the following articles may be utilised—laths, switches, rushes, reeds, straw, brushwood, twigs (arranged as in figs. 46, 47, and 48), heather, leather straps, such as a trace or stirrup leather, or strips of tin. There is very little difficulty in converting the many articles found about a house, farm-yard, or in fields, into temporary splints, but even with the best and most perfect, which will answer for use in permanent hospitals, there are some fractures in which it is almost impossible to keep the broken ends of the bones in position during transport.

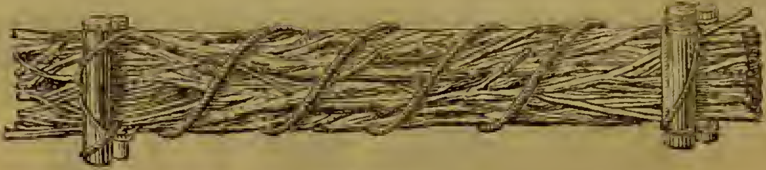

Fig. 46.

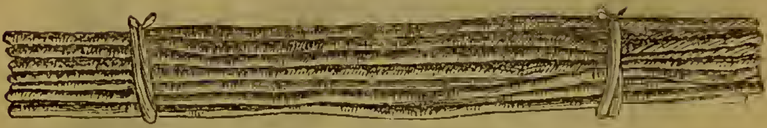

Fig. 47.

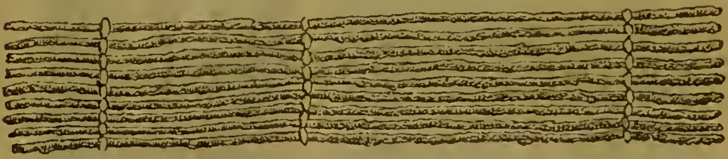

Fig. 48.

Bark of trees Mr. Benjamin Howard of New York has made use of with great advantage. Telegraph wire has been suggested by the author, the great difficulty with it being a means of cutting it at the exact point required. This has been obviated by constructing a file on the outside of one of the blades of the straight scissors (fig. 49) in an ordinary pocket-case; this is capable of cutting a notch in the wire, and so weakening it that it may be broken with ease. Fig. 50 represents a splint for a leg or forearm; the latter being considerably shorter and narrower.

Fig. 51 represents a splint for the outer side of the upper arm, one end being bent over the acromion, and the other under the olecranon, as might be done with a piece of leather strap. Fig 52 is an inner or back splint for the upper arm. Fig. 53 represents an angular splint for fractures of the lower end of the humerus, or injury of the elbow. These splints may be made more splint-like by having strips of the soldier's clothing, bandage, or other soft material rolled round them, when they will be found capable of supporting any fractures. For fractures of the thigh it is only necessary to select a larger wire and prolong the splint (fig. 52).

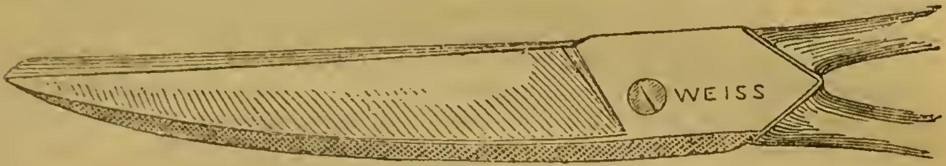

Fig 49.

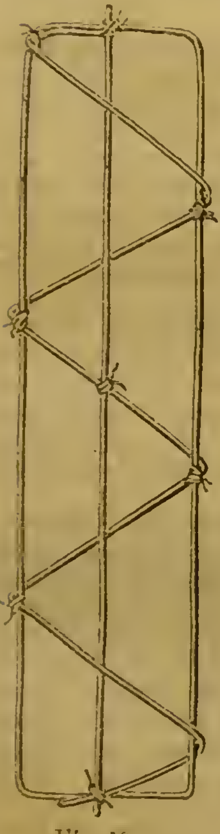

Fig. 50.

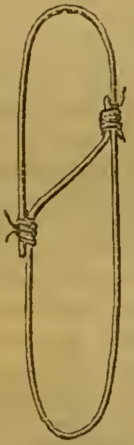

Fig. 52.

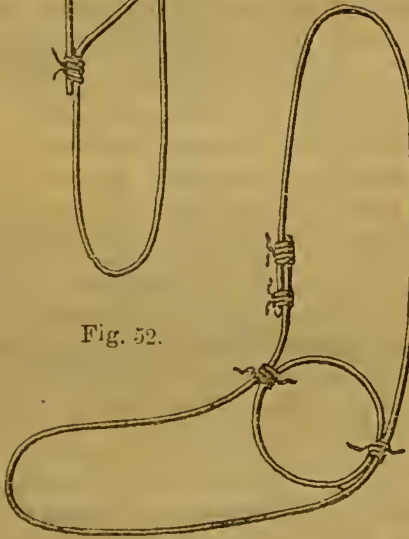

Fig. 53.

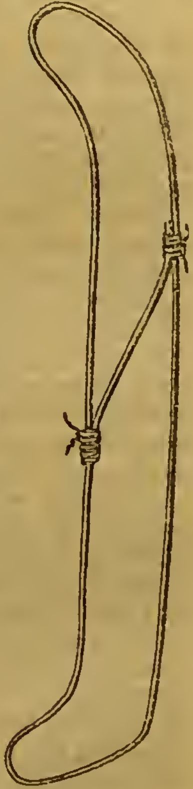

Fig. 51.

Surgeon-General Gordon records an ingenious adaptation of extemporised wooden splints: "Cotton-wool being placed as a cushion upon the splint, it is then applied, a series of silicate of potash bandages at intervals securing the whole in such a way as to render the divided ends of fractured bones quite immovable. The wound itself is left uncovered by the splints, openings being left in them for the purpose." *

Extemporary Pads and Cushions.—The army surgeon may at times be under difficulties as regards the construction of pads or cushions; they may, however, be made with cotton-wool, tow, oakum, chaff, shavings of cork or horn, cut straw, hair, cut paper, feathers, dried sea-weed. bran, dried leaves, felt, saddle cloths, articles of clothing, saw-dust, which latter, if taken from any of the pine species, will be found to contain powerful deodorising qualities

Plaster of Paris has been much used of late years for securing fractures on the field, and though its preparation causes great delay, still the results have been highly satisfactory. During the operations before Plevna, August, 1877, and at Shipka (Russo-Turkish War, 1877, 1878), 950 gypsum bandages were applied in the course of a few days, and it is confidently asserted that in the campaign, thanks to gypsum, the treatment of gun-shot wounds traversing the limbs has been most successful.†

Many plans have been proposed for its application, but the surgeon should make himself familiar with its nature and its preparation before attempting to apply it on the battlefield.

Billroth remarks on this subject: "I consider the treatment of gun-shot fractures by fenestrated plaster-bandages as the only proper method (excepting perhaps those in the upper part of the arm or thigh); the only thing against it is that surgeons who have not already treated open fractures with plaster dressings, and are not adepts in the application, should not make their first experiments on gun-shot fractures, but should only apply dressings with which they are familiar."

Pirogoff, who claims priority of the invention, gives the following account of the process for its application: "A drainage tube is drawn through the wound, which is either covered with charpie or united by sutures, a roller of flannel, cotton, or other rough texture is applied over the entire limb, and on this the plaster of Paris is smeared; a large piece of wire gauze is then taken, an aperture corresponding to the size and position of the wound cut out, and with the remainder the limb is closely enveloped. Plaster of Paris paste is again laid on, and finally the whole is fixed by one or more layers of paste bandage, additional turns being given in the vicinity of the fenestra, if extra strength is required. When the material has fully hardened, the fenestra is opened through the parted bandage by means of a strong scalpel. The plaster of Paris bandage may be put on either at the bandage-place preparatory to transport, or subsequently in the hospital for the purpose of treatment; in the former case without fenestra, providing the distance to be accomplished is not too great, and that the appliance can be removed on arrival. Pirogoff does not delay its application on account of inflammatory swelling, but he slits the bandage up the whole length, and so converts it into a case out of which the limb can be taken and cleaned when required. When the swelling subsides, the ordinary plaster of Paris bandage must be substituted. He lays down the fundamental advantages of the appliance as follows :—

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* *Lessons in Hygiène and Surgery*, by Surgeon-General Gordon, p. 128.

† Russian Medical Journal, "Sooraymenaya Meditsina."

" It exercises a uniform circular pressure throughout the entire length of the limb, thereby paralysing the attacked muscles ; it secures immobility to the broken fragments ; and it keeps up continuous extension to a certain extent when put on and allowed to harden while the limb is extended. The firm unyielding capsule formed by this bandage when it embraces the joints above and below the wound prevents the further approximation or riding of the broken ends, and keeps the limb on the constant stretch. Finally, the fenestra in the bandage must be so arranged that the fixit of the bandage must not be lessened."*

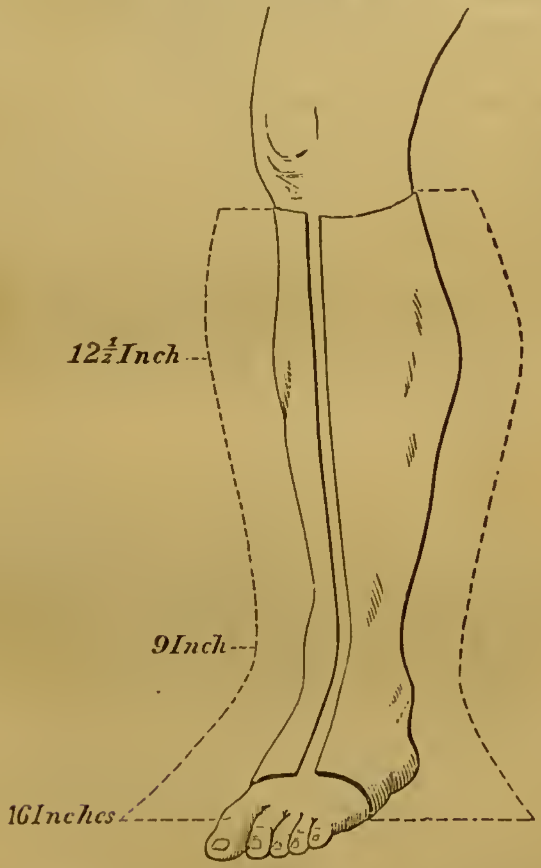

Fig. 54.

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* *Medical Times and Gazette*, August, 1873.

Surgeon-Major Moffitt, who has made several experiments in connection with the employment of plaster of Paris as a means of forming splints or supports to facilitate the transport of men suffering from gun-shot fractures, recommends the following mode of application :—

"Plaster of Paris in a proper state, water, spermaceti ointment, a small basin and a spoon being in readiness, a piece of flannel is to be cut, of shape and size fitted to envelope the limb, with the exception of a longitudinal space of about half an inch in breadth between its edges. If for the leg, it should be of the shape shown by the dotted line in the illustration (fig. 54).

"The limb should then be greased with spermaceti ointment, and the hairs smoothed down to the skin, or, what will be found to answer as well, if not better, a calico roller may be wound spirally round the limb, and divided at a later period, after the plaster covering is applied, along the vacant interval between its edges. The calico will not only prevent the hairs from sticking to the plaster, but will also form a neat lining for the splint. Either of these steps having been taken, equal parts of plaster of Paris and water should be quickly and thoroughly blended together by stirring, and in this mixture should be immersed, with the

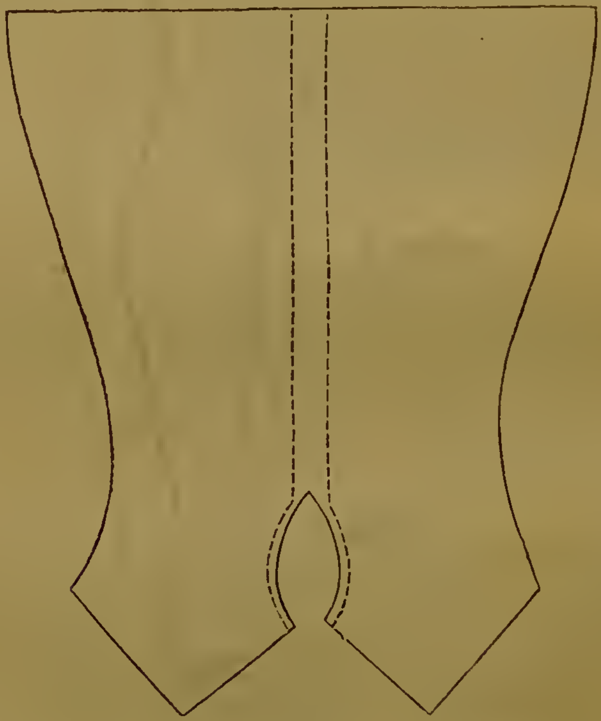

Fig. 55.

hands, the piece of flannel about to be used. When the flannel is well saturated, and its surface completely covered with plaster, it should be withdrawn from the basin, the folds and creases stretched out of it, and it should then be applied and pressed to the limb so as to fit it accurately, without, however, permitting its edges to join each other; the object of this last precaution being to leave a narrow open space up the whole length of the limb, to allow for the occurrence of swelling. In this position it should be held steadily until the plaster has set, which will generally not occupy longer than five minutes. The illustration shows the splint applied to the leg. Should the splint, however, after the plaster is set, be considered not to have strength and firmness enough, another layer may be applied over it exactly in the same way. A roller may now be applied lightly over the whole.

"The quantity of plaster requisite for a leg is about eight ounces; for the thigh and arm in proportion.

"Should it be desired, however, to make the plaster more secure, or to continue its application as a permanent splint, this may be done with great facility by the addition of a little dextrine. This will be best accomplished by taking a piece of flannel of the dimensions similar to that used for the plaster of Paris, coating one side of it over with a thick solution or paste made with the ordinary dextrine, and applying it over the plaster of Paris splint already in use."

Neudôrfer recommends a very simple plan for the application of plaster of Paris bandages:—"Compresses of linen or of lint are dipped in the plaster of Paris of the consistence of a common poultice. These are then placed longitudinally on the limb, first on the upper, then on the under part. A few turns of a bandage keep them *in situ* till the plaster is set. To prevent the contiguous edges adhering, they are lightly greased, or a slip of greased lint is put between them."

At the Congress of Military Surgeons held in Paris, 1878, Neudôrfer exhibited another method. He encloses dry plaster between folds of cotton or linen cloth, this he thoroughly saturates with water, which he presses out by passing a piece of stick rapidly and evenly over the surface of the cloth. This description of bandage dries quickly.

The mode of applying the plaster apparatus, as practised in the *Bavarian Army* during the late Franco-German war, is as follows:—"Two pieces of flannel, 20 inches broad, are stretched together for the leg, as represented in fig. 55, and stitched down the middle; and beyond this both are cut through in the same line for the length of the foot. The flannel is placed under the limb, so that the seam reaches from the ham to the heel. The sides of the inner piece are brought together over the leg, and fixed in front and along the sole by pins (bent at right angles (fig. 56), so that they may be easily extracted afterwards), and thus a closely-fitting stocking is formed. The sides of the outer piece are then brought forward and cut, so that each may overlap the middle line of the leg and sole by three-quarters of an inch. The limb is then laid on one side, and, while this

Fig. 56.

outer piece of flannel is held back, a layer of plaster of Paris, of the consistence of thick cream, is spread evenly to the thickness of half an inch over the inner piece, and made to pass quite to the seam behind and the line of juncture of the sides of the inner piece in front. The outer piece is pressed over this before it sets, and should just reach the middle line in front and along the sole. When this has set, the limb is turned over, and the process is repeated on the other side (fig. 57). The pins may now be removed. The seam serves as a hinge; and when the whole has set the splint may be taken off, the edges of the plaster trimmed, and those of the inner piece of flannel cut so as to leave sufficient to turn over and stitch down on the outer piece. The splint is then readjusted and fixed by a bandage. The setting of the plaster may be retarded by the addition to it of solution of borax. Thus, a solution of one part to twelve of the water used will retard the setting fifteen minutes.

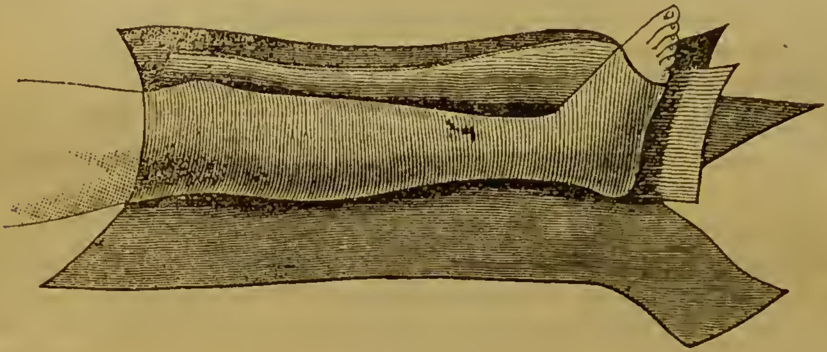

Fig. 57.

From experiments made at Netley, the following are the quantities of plaster of Paris required for each of the different bandages by the Bavarian method :—Leg, 24 oz. ; thigh, 28 oz. ; elbow and forearm, 16 oz.

Volcer has devised a plan for applying a plaster of Paris bandage to a fractured thigh, which is as follows :—If time admits, give chloroform, and keep the patient under its influence till the plaster hardens. The patient should be kept perfectly steady. The extremities, from the toes

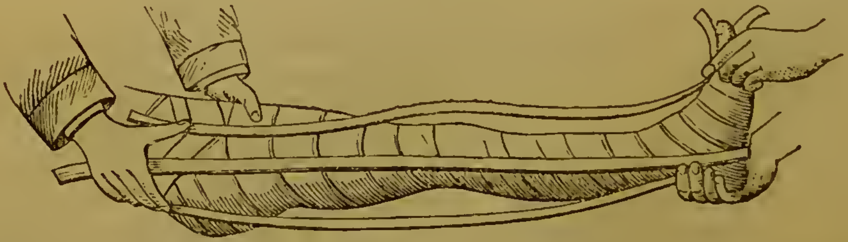

Fig. 58.

to the haunch, must be enveloped in wadding, which is to be cut into strips 4 inches in width; this wadding is then to be covered with moist gauze, which keeps it in position; over this narrow strips of thin wood (fig. 58), so flexible that they can be rolled like a bandage, are to be placed on four sides of the entire length of the limb. Two attendants fix with their hands these long splints until an ordinary plaster bandage, which has been dipped in water, has been placed round the limb, by means of which the splints are firmly fixed (fig. 59). Then five or six plaster bandages are used from the toes to the haunches, carrying the bandage well round the hips. Care should be taken that the plaster bandage does not extend over the wadding at the hips and abdomen, and that an orifice (fig. 60) is left for discharges and application of dressings in the event of there being a wound.

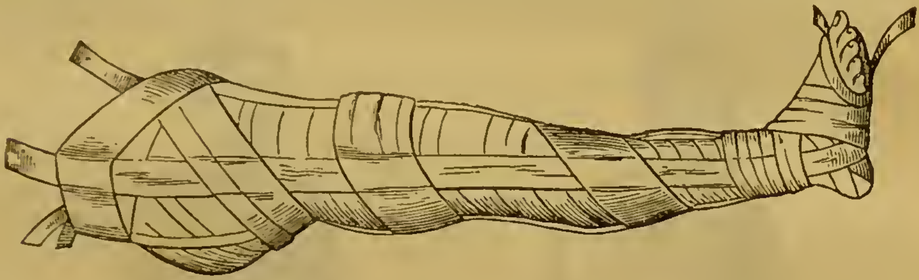

Fig. 59.

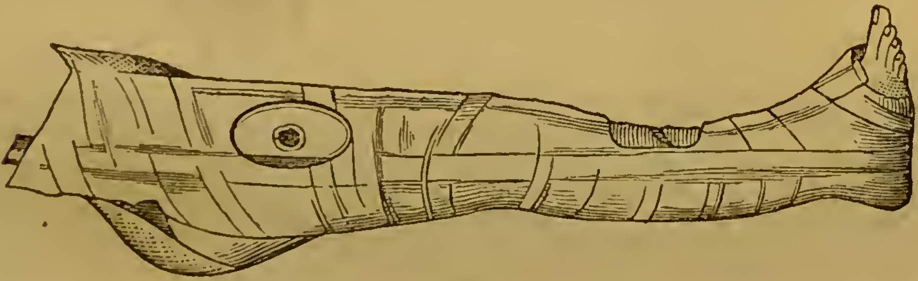

Fig. 60.

Arm Slings.—The most convenient form of sling for supporting an injured arm is the triangular bandage already referred to (fig. 24); but, in the event of one not being available, the skirt of an infantry soldier's tunic may be slit up at the side and secured by a pin, as shown in fig. 61. The skirt of the artillery and cavalry soldier's tunic being much shorter, the sleeve of the injured side may be utilised by being slit up and secured, as represented in fig. 62.

FAT-EMBOLISM.

Fat-embolism, as a sequence of fractures, consists in the passage into the veins of liquefied fat which is carried into the lung, brain, and spinal cord, blocking up the capillaries of these organs. A condition liable to bring about fat-embolism is a crushing violence to the bones, so that the cancellous texture is much broken up, and the medullary fat thus set free. The symptoms are apt to be taken as those of shock, occurring as they do in the first two or three days after the injury. Its onset is marked by transient attacks of dyspnœa, with irregular action of the heart, slight hæmoptysis, and at first shallow breathing, at times interrupted by deep sighing inspirations, subsequently the peculiar form of breathing known as "Cheyne-Stokes" manifests itself. Collapse with marked pallor of skin and mucous membrane soon ensues; fat has been detected in the urine. Czerny thinks this condition in a very slight degree is a constant attendant upon cases of fracture.—*Encyclopedia of Surgery by Ashhurst.* It has been observed as a result of other injuries besides fractures.

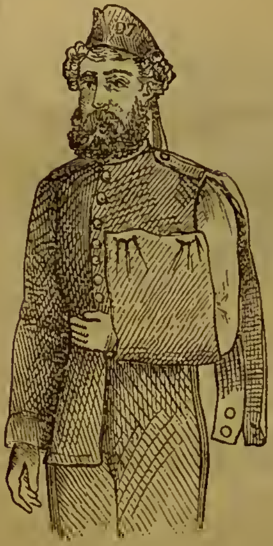

Fig. 61.

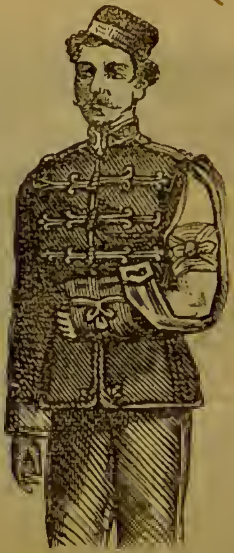

Fig. 62.

WOUNDS.

Wounds, how inflicted.—Wounds inflicted in war may be produced by missiles projected by some explosive material, such as bullets, gun shot, shrapnel, shells, grape and cannister shot, and slugs, which come under the head of gun-shot wounds. There are other wounds produced by sabre, bayonet, or lance, and indirectly by fragments of substances struck by bullets, shot, or shell, such as stones, wood, metal, and even by fragments of the bones of comrades, or by explosion of the engines of war above and below water. Arrow wounds are occasionally met with.

Nature of Wounds.—From the depth to which wounds extend they are denominated *superficial*, *muscular*, and *penetrating:* and from the nature of the weapon with which they have been inflicted they are characterised as *incised*, *punctured*, *lacerated*, and *contused*. They may also be classified according to the region of the body, as, for instance, *wounds of the head*, *face*, *neck*, *thorax*, *abdomen*, and *extremities*.

Treatment of Wounds.—It will be convenient to describe here the antiseptic treatment of wounds in general, and then in connection with regions.

"The principle insisted upon by Sir Joseph Lister is that the decomposition of fluids in wounds, their putrefactive changes in short, are directly dependent on their impregnation with organic matter floating in the air and thence deposited, or, in other ways conveyed to them, fermentative and putrefactive changes being thus at once set up in the fluids of the wounds; that such local actions are capable of producing general septic infection of the fluids of the body, and further, that those organic products may be excluded from the wound, either by their destruction in the air by chemical agents such as carbolic acid, or their separation from it by filtration as by layers of cotton wool."—*Erichsen.*

"No organic body has any inherent power of putrefaction, and no inherent power of generating bacteria, but bacteria are the actual agents of decomposition, and absence of bacteria coincides with absence of decomposition."—*Roberts.*

Putrefaction in wounds exposed to the air is not due to the air itself, but to the solid particles floating in it, and deposited upon everything as dust upon our bodies, clothes, food, water, instruments, &c. This dust consists largely of micro-organisms and their spores, which, coming in contact with a suitable pabulum, commence to develope and thus set up the putrefactive fermentation, the product of which Panum showed to be a chemical compound extremely poisonous, and which Bergmann states he has been able to separate as a crystalline body, which he calls *sepsin.* This poisonous chemical product of putrefactive fermentation is called a ptomaine. A ptomaine is defined by Brieger as "an alkaloid formed in albuminous bodies during the putrefaction which is set up in them by bacteria." Bacteria cannot live in healthy living tissue. "The healthy tissues are an unsuitable soil for them, they cannot grow in it, or in other words, septic bacteria are not parasites on the living tissues, hence the immunity we have in swallowing them and when injected subcutaneously; but contact with dead tissues never fails to produce successful septic inoculation."—*Roberts.*

These organisms, therefore, coming in contact with wound discharge, as serum or pus, set up in it the putrefactive fermentation, which yields as products the poisonous chemical compound known to exist in all putrid fluids, the absorption of which from the wound causes constitutional disturbance, varying in character according to the quantity absorbed, from the mildest form of traumatic or surgical fever to the severest kind of septic intoxication. "If, however, the entrance of bacteria and the occurrence of fermentation are prevented, this traumatic fever does not occur. It subsides when granulation of the wound is complete, *i.e.*, when absorption cannot occur. When the kidneys are diseased and the excretion of poisonous substances is therefore imperfect, the absorption of a much smaller amount of this material will cause grave symptoms and even death than would be the case if the kidneys were healthy. The products of putrefaction and fermentation are, however, not only poisonous when absorbed, but they are irritating when applied to the surface of a wound, and cause inflammation and suppuration."—*Cheyne.*

"Micro-organisms such as the bacillus, and micro-coccus, are spoken of as 'organised irritants' or 'pathogenic fungi' from their direct power of exciting unhealthy processes. They infest the living tissues increasing in quantity among them, and, exciting inflammation as they spread, they enter the circulation by the lymph stream, or by the blood-vessels. They may multiply in the circulating blood, giving rise to changes incompatible with life, or they may lodge in distant parts and there grow and set up local inflammation similar to that at the original seat of the disease. The poison thus multiplies in the body, and the effects it produces are not proportional to the quantity of the original dose inoculated. To inflammations arising from this cause, the term 'infective' is applied."—*Erichsen.*

They are the immediate cause of all forms of traumatic infective disease, under which is included pyæmia, septicæmia, erysipelas, hospital gangrene, phagedæna or wound diphtheria, osteo-myelitis, and in Germany some eminent surgeons would add tetanus. The so-called burrowing of pus in unhealthy wounds is thus due to their spreading in the tissues, which is followed by inflammation and suppuration. Also the secondary hæmorrhage occurring in suppurating wounds in the second or third week, is mainly due to a softening and diseased condition of the walls of the artery, brought about by the spread of these organisms in the neighbourhood, causing septic inflammation in the surrounding tissues.

The causes of putrefaction and wound infection being thus shown to be due to the entrance of germs into the wound, it will be evident that to prevent putrefaction of the discharges, the wound must be protected from all chance of invasion of the organisms, or if this cannot be done, the wound must be so surrounded by a chemical atmosphere as will interfere with and prevent their power of development. To this method the term "aseptic surgery" has been given, which aims at the total exclusion of germs. On the other hand, supposing the wound to have been exposed to the air and to have been rendered septic, then we can only attempt to treat it by using such applications and measures as will impede and prevent further development of the micro-organic life that has already gained access. This has been termed "antiseptic" treatment in contradistinction to the former which aims at a total exclusion of all germ life from the commencement.

The best mode of treating a wound and preventing all access of germs was by the well-known Listerian gauze dressing, but this is now giving way to a simpler form of dressing, in which absorbent cotton is the medium, and corrosive sublimate the antiseptic. The latter has been in use for some time, and has proved itself to be a thoroughly reliable antiseptic. It is getting more and more used, and promises to be the antiseptic for general use. This will be a great gain as the numerous things now required to be carried are inconvenient and puzzling. A recent order in the German army abolishes all other antiseptics, and orders corrosive sublimate as the only one to be used in military hospitals.*

A description of the method of applying a gauze dressing is now given to illustrate the need of strict attention to cleanliness in every detail. The spray is not used. as it is found that frequent washings of the wound with an antiseptic solution during the operation are sufficient to preserve the wound from outside contamination.

"Before applying a gauze dressing, the skin near the seat of operation is carefully washed with 1–20 carbolic lotion at least an hour or two before the operation. The instruments should also be soaked in 1–20 carbolic lotion for an hour before use. The surgeon and his assistants wash their hands thoroughly in a 1–40 solution. A towel well soaked in the same solution should be so arranged as to be convenient for the surgeon to rest his instruments upon during the operation. Hæmorrhage is to be arrested by forci-pressure, catgut ligatures, or by torsion; suitable drainage tubes are placed in position, and the wound is then stitched up. The surgeon applies a piece of protective, but little larger than the wound, the protective being, of course, dipped in the 1–40 carbolic solution. Outside this is placed a piece of wet gauze consisting of several layers of loose gauze which have been soaking for some time in the 1–40 carbolic solution. This wet gauze and protective are called the deep dressing. The wet dressing must overlap the protective in all directions. Then any remaining hollow is filled up with loose gauze, and outside the whole a gauze dressing is fixed. This dressing consists of a piece of carbolic gauze of suitable size folded in eight layers, and having the macintosh placed beneath the outermost layer with the india-rubber side inwards. The dressing is fixed by means of a bandage, and when this is accomplished, the spray, if in use, may be stopped. Then around the edge of the dressing an elastic bandage is applied, so as to keep the edge constantly in contact with the body, and to allow no interval to occur between the dressing and the skin during the movements of the patient. The elastic bandage is carefully fixed to the edge of the dressing by means of safety pins. In the after progress of the case, the dressing is changed as soon as any discharge shows itself outside, though in no case is it left on longer than eight days."—*Cheyne.*

Drainage, says Cheyne, is the point next in importance to keeping a wound aseptic. For if the blood and serum which collect in the interior of a wound in the first twenty-four or forty-eight hours do not get free exit, they give rise to tension, and tension to inflammation, and the latter to suppuration. "The value of a drainage tube in preventing the accumulation of blood, of serum, and of pus cannot be over-estimated. It is the greatest safeguard we have against the accumulation of decomposable fluids in the wound, and, more than any other means, favours cohesion of its opposite sides, and secures the patient from all danger of septic contamination. Its use should never be omitted, especially if the wound be deep and irregular, or if there be any bagging under a flap."—*Erichsen.*

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* *Vide* Appendix.

The best drains are those made of red india-rubber—the tube must not project beyond the surface, and a loop of silk should always be fastened into it at its orifice. It is better to use two or more smallish tubes than one large one, because on the day after the operation one of these may be removed altogether. "No tube," says Cheyne, "which one wishes to put back again, should be removed until the third day on account of the difficulty in returning it. Generally on the third day half the tube is cut off, and it is reduced in length at subsequent dressings till it becomes no longer necessary." Sinus forceps are of the greatest use in inserting drainage tubes, and every pocket-case ought to contain a pair.

"Sponges should be well washed after an operation, and then kept in a jar containing 1-20 carbolic solution, during an operation they are washed in a 1–40 solution. Sponges after use often become filled with fibrin, and thus rendered useless. Lister, therefore, after an operation places the sponges in a tank containing water, putrefaction of the fibrin occurs, and after some days the sponges can be easily cleaned. They are then placed in a 1–20 carbolic solution."—*Cheyne.*

In stitching up the wound, having placed the drainage tubes in position, the edges of the wound should be brought closely and accurately together by silver wire sutures rather deeply placed at regular intervals, and between these the edges of the skin should be correctly approximated by wire or catgut sutures. If no drainage tubes are used, the stitches must be an inch apart. "In changing the outer dressing the deep dressing need not be touched, if it be left on it must be remembered that the carbolic acid will have evaporated, and that, therefore, it must be treated as the wound—*i.e.*, it must be overlapped in all directions by a piece of wet gauze, and that again by a dressing of suitable size."—*Cheyne.*

In the case of large or deep wounds made accidentally, or by gunshot, where, perhaps, some hours have elapsed before the case comes under the surgeon, the practice is somewhat different. Here septic particles or germs may have gained access to the wound, and it is, therefore, most important to try and destroy them, and prevent others from gaining entrance. This would be best accomplished by thoroughly washing out the wound or joint with a 1–20 carbolic solution, or 1-500* mercurial solution, by means of a syringe and catheter, taking care that the solution is brought in contact with every part; a drainage tube should be inserted and the edges of the wound brought together by sutures, and the wound dressed with an antiseptic dressing so arranged as to be kept close to the surrounding skin, and thus prevent the direct access of the air.

The irrigation plan of treating wounds acts by washing away discharge so quickly that it has not time to putrefy, and if the wound have already become inflamed, it is cooling and grateful to the patient. The *constant water bath* acts by keeping the air from coming in contact with the wound, the water in the bath would have to be carbolised or iodised, but it is an inconvenient mode of treatment, and has many disadvantages.

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* *Vide* formulæ at the end of the book.

The open method, in which a wound is simply left open with a view to the evaporation and concentration of its discharge and the admission of oxygen, so that a crust forms under which healing proceeds, though the usual mode of healing in animals, does not answer so well with man. The formation of the crust or scab has been aided by adding various powders as bismuth, burnt alum, powdered guaiacum, salicylic acid, &c. The plan could only be reccommended in superficial and small wounds, as the risk of accumulating discharge without drainage would be too great.

The antiseptics chiefly in use are—

Carbolic acid, which is used in a 1–40 and 1–20 solution in water, in a 1–5 solution with rectified spirit, also with oil or gylcerine as 1–10 and 1–20, we have also carbolised cotton wool and tow. It is a powerful germicide, but it is extremely irritating, and interferes with healing by destroying granulation tissue. Granulations are non-absorbent, if, however, the superficial layer of granulation tissue is destroyed, the wound surface is capable of absorbing any poisonous matter that may come in contact with it. Therefore, except in the first instance to purify a wound, carbolic acid, if used, should not be allowed to come in contact with the wound surface, but this latter should be shielded from it by a piece of protective. It is poisonous and very volatile.

Corrosive sublimate or mercurial chloride is a most powerful germicide. It is used in solution and in several prepared dressings. The solution 1–500 may be used for all purposes that 1-5 spirit solution of carbolic acid or the 1-20 watery solution would be applicable—*i.e.*, for the thorough purification of accidental wounds or gun-shot injuries when first brought before the surgeon, but after the first purification, 1–2000 is the strength sufficient to maintain asepsis; 1–5000 may be used for irrigation during an operation, and 1-10,000 for washing out the abdominal and pleuritic cavities. In dressing wounds it is applied on lint which has been soaked in the 1-2000 solution. It is apt to produce a troublesome eczema on some skins, and will blister if applied in a too concentrated solution. The wood wool owes its antiseptic virtues to this drug, and forms a dressing that cannot be too much recommended for all suppurating wounds. It is light, absorbent, and highly antiseptic. The wood wool should be put in bags of gauze or muslin, and applied dry to the wounded surface. There is also a preparation termed "alembroth wool," which is absorbent cotton impregnated with the mercuric chloride, and coloured blue by means of an aniline dye which is so incorporated with the salt, that, as the sublimate is washed out by the discharge, the blue colour disappears with it, the white wool remaining, showing that all the antiseptic has been dissipated. Another preparation consists of "Gamgee tissue," coloured and saturated as the alembroth tissue. Both of these are most valuable preparations, and seem likely to supersede the use of carbolic acid and its preparations in the treatment of wounds. The mercurial chloride is very poisonous, non-volatile, cheap, not very soluble in water, but very so in glycerine. The solution can be coloured red by fuchsin.*

Boracic acid has weak germicide action; it is used in solution on prepared lints and cotton wool, and as an ointment. The ointment consists of two strengths. The strong 1–5 is adapted for dressing deep wounds, &c., and the weak is one of the best applications for all superficial and granulating sores. It is antiseptic and quite unirritating. Several folds of lint soaked in warm boracic lotion, and applied to a part when covered with oil-silk or guttapercha, forms the antiseptic poultice.

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* Rose aniline dye.

Salicylic acid has a stronger germicide action than boracic acid. It is used in the same way. Cheyne says that Thiersch uses jute instead of cotton to impregnate with this acid. This jute is made from the bark of various species of corchorus grown in Bengal, and is cheaper than cotton wool, and, at the same time, more absorbent.

Iodine has a great antiseptic power, and is a good application to wounds to check any putrefactive action, it is best used in solution of ʒij to one pint of water. To obtain perfect hæmostasis after operations, Mr. Bryant recommends the application of a sponge wrung out of iodine water at 130°F.

Iodoform acts well, owing to its readily parting with iodine. It is used dry in the precipitated and crystalline forms, and in preparations as iodoform wool, gauze, and ointment. Dr. Oppler mixes iodoform with finely powdered coffee, and maintains that its peculiar odour is thereby lost. It produces in some cases poisonous effects, the chief symptoms of which are a "high temperature (104°F.), loss of appetite, emaciation, patient complains that everything smells and tastes of iodoform, there is a quick pulse, violent delirium in some cases, drowsiness in others."—*Erichsen.*

Sulpho-carbolate of zinc is highly recommended as an antiseptic by Dr. Bottini, of Pavia. It is readily applied in solution, and is a good injection in gonorrhœa.

Chloride of zinc is a powerful antiseptic. It is used in solution of 40 grs. to the ounce of water, and is said to have the property of preventing putrefaction in a wound for some time after its application, and is especially useful in all wounds communicating with the mouth, rectum, or bladder. It is most useful for all wounds when there has been any foul condition of the surface, or in sinuses. Sir Wm. Burnett's solution contains 300 grs. to the ounce—so 1 ounce diluted with 7½ ozs. of water will make a solution which would contain 40 grs. in the ounce.

Eucalyptus oil is a very powerful germicide. It is used in solution in olive oil 1–10, also in gauze, and as an ointment. It is most useful in all foul wounds near the anus, perineum, scrotum, &c.

Burnt Alum and *Bismuth* have both been recommended as good hæmostatics and as applications to wounds.

Alcohol is a good antiseptic. It has been much recommended by Mr. Jonathan Hutchinson, who uses as a dressing to his operation wounds a lotion composed of 6 parts of absolute alcohol, a half part of Liquor Plumbi, and 16 parts of distilled water—compresses of lint are soaked in this and kept damp with it during the day.

Condy's Fluid has active powers as a germicide, and is a good wash when diluted for foul sores.

Chlorinated Soda solution, ʒss to the ounce of water, is said by Dr.

Cabot to stand next to the 1-20 carbolic solution in rapidity of action on bacteria. It is a good application to wounds when there is much fœtor. The balsams, as Tinc. Benzoin Co., &c., are most useful applications to old, indolent, and septic wounds.

Cotton wool is a good covering for wounds, it acts by filtering the air, and thus allowing no dust or germ to reach the wound. Absorbent cotton is a better preparation as it quickly soaks up any discharge.

Tenax or marine lint is a good antiseptic, but is harsh, and should therefore not be placed next to the wounded surface, but it forms a most useful outer covering.

Suppurating Wounds.—If, when a wound comes under notice it is already foul and suppurating, we must endeavour to destroy the causes of putrefaction which have gained admission, and to hinder the development of fresh organisms in it. This is to be accomplished by the use of one of the antiseptics, scraping away old granulation tissue by means of a Volkmann's spoon, free drainage, and in a large wound with cavities by irrigation with some antiseptic solution. Dry dressings have much to recommend them, the surrounding skin is kept healthier and in better tone than by constant wet applications; the less watery the discharge the less danger of its putrefying. Then, again, a dressing should not be changed oftener than is absolutely necessary. If a wound has been purified by the chloride of zinc or other solution, and is rendered quite aseptic, there can be no object in changing a dressing unless discharge should have come through; but, on the other hand, if the discharge is decomposing it cannot be removed too quickly.

When the wound is granulating the weak boracic acid ointment is one of the best dressings, it need not be changed oftener than every two or three days. An elevated position of the part with good equable bandaging helps the healing process very considerably by favouring the weakened circulation. Poultices and water dressing favour in the highest degree the development of bacteria and consequently suppuration—they should not be used. Water, being the especial habitat of bacteria, should not be used at any time for washing wounds.

No probe or director, at any time, should ever be introduced into any wound or sinus without first having been dipped in a solution of carbolic acid 1-20. It is a good plan to have a wide-mouthed bottle in the dressing-tray filled with this solution for this especial purpose. It is then always at hand, the use becomes a habit, and there is no unnecessary waste.

Incised wounds should be thoroughly purified by the carbolic or mercuric solution, the parts should then be brought together and maintained so by suture; if, however, the wound is very deep or extensive a drainage tube will probably be required, the wound should then be covered with a dry antiseptic dressing, the part elevated, and a good equable bandage applied.

Punctured wounds (such as may be produced by a bayonet) of the soft parts are peculiarly liable to excite inflammation in the neighbouring textures; to promote the formation and confinement of matter under the fascia; to cause injury of deep-seated vessels and consequent hæmorrhage; and to induce tetanus by lesion of a nerve, Should a foreign body be suspected, it should be searched for and removed, the wound should be well washed out with an antiseptic solution, a drainage tube inserted, and the wound dressed with some dry absorbent application. Should no foreign body be suspected, and the lips of the wound fall together, no examination should be made, but the wound should be covered with a dry dressing and the parts gently but evenly supported by a bandage. In the event of the wound becoming inflamed the greatest attention must be paid to prevent the retention of discharge, free drainage should be established, and the wound surface dressed with wet boric lint under an oil-silk or gutta-percha covering.

Lacerated wounds are such as are inflicted by blunt obtuse bodies destroying to a certain extent the vitality and organisation of the textures. There is usually little hæmorrhage, but the pain may be very severe. If the wound has been made by a cannon shot, the parts will present a very ragged surface, the skin being stripped away, the tendons in all probability hanging out, bellies of torn muscles protruding, and the vessels exposed, but no hæmorrhage. These wounds are very slow in healing, in consequence of the superficial parts being disorganised; sloughing must first take place, after which the wound will heal by granulation. These wounds are particularly liable to traumatic gangrene, and in the head to erysipelas.

In no class of wounds is the effect of antiseptic treatment more marked than in these injuries. In the experience of the writer, sloughing and suppuration is greatly lessened, and tissues that appear quite destroyed recover themselves in a wonderful manner. The injured part should be thoroughly cleansed and purified by one of the stronger solutions, as the chloride of zinc 40 grs. to 1 oz., or the 1-20 carbolic solution, or the 1-500 mercuric chloride. The torn tissues should then be replaced in their proper positions, tendons and nerves if divided should be united by suture (chromic gut), and the whole covered with a full gauze dressing, or by folds of the Alembroth or other antiseptic wool. These dressings should not be removed unless discharge comes through, or some signs of putrefaction show themselves. The writer always inclines to dry absorbent dressings instead of wet if possible.

Wind Balls.—Extensive injuries to internal viscera have been inflicted without any sign of an external lesion; bones have been broken, and yet no sign on the external skin of contact with any missile. These injuries are produced by what are known as wind balls, which many authorities on gun-shot wounds have endeavoured to explain.

Sir T. Longmore considers that "the true explanation of the appearance presented in those cases which were formerly called wind contusions, appears to rest in the peculiar direction, the degree of obliquity with which the missile has happened to impinge against the elastic skin, together with the relative situation of the internal organ injured to the missile, and to other hard substances in the neighbourhood. The surface itself is not directly torn or cut into, because the impact of the projectile has not been sufficiently direct to effect an opening; but the parts beneath are crushed by the pressure to which they have been subjected between the combined influence of the weight and the momentum of the ball or shot on one side, and of some hard resisting substance on the other. Thus, on a cannon ball passing across the abdomen, the elasticity and ready mobility of the skin may enable that structure to yield to the strain to which it is exposed, while viscera are ruptured by the projectile forcing them against the vertebral column. So the weight of a ball passing obliquely over the forearm, may possibly crush the bone between itself and some hard substance against which the arm may be accidentally resting, without lesion of the interposed skin."

Wounds, whether received directly or indirectly, may be complicated by the entrance of extraneous bodies, such as portions of clothing worn by the wounded, or various articles which may have been about his person.

GUN-SHOT WOUNDS.

How Gun-shot Wounds are Influenced.—Gun-shot wounds may be influenced by the shape and weight of the missile, its velocity, and the structure injured. For instance, a conical bullet will do more injury to a bone and soft parts than a round one of the same weight and fired at the same proportionate distance; and a hollow conical bullet will cause more damage to the soft parts, periosteum, and bone than a solid, both being fired under the same circumstances. The position a limb may be in at the time of being struck will influence the direction of the wound; also a very slight obstacle, such as a button or a coin, and even a tendon in a state of tension has been known to turn the course of a *round* bullet. This is scarcely possible with the conical bullet fired at a short distance, which has such force as to pass directly through a limb, smashing all before it.

Examination of Wounds.—It is of the greatest importance that, on all occasions, strict cleanliness should be observed in the examination of wounds, especially on the battlefield, when the surgeon may inadvertently poison wounds by conveying dirt and blood and other septic matters on his hands. Wounds, therefore, should not be examined or fingered on the field of battle, but only interfered with in cases of hæmorrhage or from some other urgent necessity. The surgeons of the first line of assistance should content themselves with applying some antiseptic covering to the wound to protect it until the patient can reach the dressing station or field hospital, where alone a thorough examination should be made. It must be obvious, upon the least reflection, that any interference with wounds on the field will be liable to render them septic.

Dr. Carl Reyher, in the late Russo-Turkish campaign, insisted "that wounds were never to be examined at the front either with fingers or instruments, nor was any attempt to be made to extract the ball. The only exceptions were in the case of hæmorrhage, and in cases where the projectile had passed through one of the large cavities of the body, and, without wounding the contents, had remained in the wall of the cavity. Here he advised the removal of the ball at once for fear that it might, if left, fall back into the cavity implicated." "For surgeons at the front," he says, "there is only one line of treatment—to occlude the wound provisionally, to lay the wounded part in a suitable position on the litter, and to render it provisionally immovable. As a provisional dressing the salicylic balls recommended by Esmarch are the best."—*Cheyne.*

On arrival of the patient at the field hospital, a thorough examination must be made. Here the surgeon will have all the needful appliances. If it is a case where a rifle ball has passed through the soft parts without injuring the bone, and there is no reason to suspect that clothing or other foreign matter has been carried in; if the edges of the wound fall fairly together, and if there has been no *previous* examination by fingers or probes, it would be right to abstain from any interference with the bullet track, and to be content with simply purifying the surrounding skin with a carbolic lotion, and then applying a dry antiseptic lint or pad to the wound of entrance and exit, and maintain the same by a good even bandage. Accepting here Esmarch's opionion "that rifle bullets passing quickly through the clothes may not carry into the wound any causes of putrefaction.' Esmarch * also writes, after reading the reports of Reyher and Bergmann in the last Russo-Turkish war, "It is evident, beyond doubt, that a much larger number of the most severe injuries of bones and joints can be aseptically healed under the dry scab than we have ever dared to hope. Even the presence of dirty pieces of clothing in the depth of the wound appears not so very rarely to allow the aseptic process, when the air has been immediately excluded."

Acting upon this experience, supposing a bullet wound to have been treated on the field as above described, and, on arrival of the patient at the field hospital, the dry dressing is found to have become agglutinated to the wound by blood, &c. Should there be no fever, pain, or other pressing symptom, this dressing should be left untouched, even supposing it to be a joint implicated, in the hope that it will heal aseptically under this scab; but measures should be taken to ensure rest and immobilisation, and the attention of the surgeon can then be given to some other wound that will obviously require examination.

Reyher is so impressed with the importance of not "fingering" a wound, that he says, "even if there is known to be cloth in it, it should not be examined, but that it should be washed out and attempts made to heal it; if, subsequently, the foreign body does give rise to irritation, it is a far simpler thing to cut down and remove it in the convenience and leisure of a stationary hospital, than to run any risk of contaminating a wound in a field hospital as all interference in the latter is apt to do."

If, however, the wound is of such a nature as to demand examination with a view to deciding upon the proper course of treatment, the sooner this operation can be performed the better, as the wound will contract and surrounding parts inflame; so that the longer a search is delayed, the greater the suffering to the soldier, and the more difficult the operation; in fact, wounds should not be explored when in a high state of inflammation.

Before the finger is introduced, it is, of course, to be well washed in the carbolic solution. Here it may be remarked that carbolic acid in solution in no way loses its powers, though it may look dirty from repeated use even though blood be mixed with it. It is by no means necessary that fresh solution should be poured out for each hand-washing, it would be sheer waste to do so, and no field hospital supplies would stand it.

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* *Langenbach's Archiv*, xxiv. April, 1879.

If the wound is too small to readily admit the finger, it should be enlarged, as the size of the external injury will not be any gauge as to the extent of injury inflicted upon the bone or bones.

Sir T. Longmore recommends the following course to be adopted when exploring with the finger:—

"The finger should be inserted slowly and steadily towards the deepest part of the wound. During its passage, the surgeon should carefully observe whether any foreign body appears to be pushed before it, or to be lying by the side of the track of the bullet, and should note any other peculiarities of the wound. He should also ascertain whether the end of the track is reached, and if this is found to be arrived at, a careful circular sweep of the finger-end will then usually settle if any, and what, foreign bodies are lodged. The surgeon should not withdraw his finger until the course of the projectile has taken, the injury it has done, the complications of the wound, such as the presence of foreign bodies, and, in such a case, their kind and situation, have been decided by him; the exploration will then be completed by one operation, and a second insertion of the finger for the purpose, which is always irritating to the patient, avoided. If the finger be not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction; and when the lodgment of a projectile is still suspected, or some other point of doubt remains to be solved, such as the direction the projectile has taken in the latter part of its course, we are compelled to make a further exploration by other means. Generally, a long silver probe, that can be bent if required, and that can be guided into a definite direction at the will of the surgeon, will be found to be the best substitute for the finger. The probe should be used with great discretion, for, without care, it may readily be made to inflict injury on vessels and other structures which have escaped from direct contact with the ball, but have returned by their elasticity to the situation from which they had been pushed or drawn aside during its passage.

"Sometimes, when the finger in the wound fails to find a lodged projectile, the particular spot in which it is lying may be detected simply by relaxing the muscular tissues, so as to give a loose and pendulous condition to the parts concerned, and then lightly tossing up the flesh at different points from below with the tips of the fingers. A bullet lodged among the soft parts will occasionally make its presence known under such an action by the impulse which its weight communicates to the top of one of the fingers when the parts, having been shaken upwards, return to their previous position. Sometimes a gentle kneading pressure in the neighbourhood of the injury, assisted by information derived from the sensation of the patient, will lead to the detection of such a foreign body;

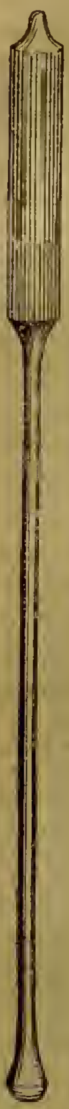

Fig. 63.

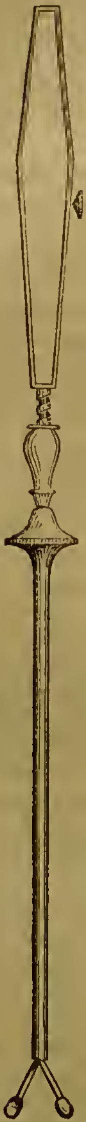

Fig. 64.

or it may be discovered by passing the palm of the hand down a limb.

"Cases in which the exploration by the surgeon's finger is altogether impracticable, and in which the use of the probe is attended with so many sources of doubt as to prevent any satisfactory conclusion in respect to the lodgment or absence of foreign bodies from being arrived at, occasionally occur." Much trouble and inconvenience will then be experienced unless the surgeon is in possession of some of the new contrivances for clearing up these doubts.

Nélaton's Probe.—M. Nélaton designed a probe for ascertaining the nature of the foreign body impacted in the bone of one of General Garibaldi's ankles. It consists of a slender rod of metal 5 or 6 inches in length, terminated at one end by a small knob of white, unglazed biscuit china. The other end of the probe is furnished with a small handle, grooved ridge-and-furrow fashion, in order that the finger and thumb may the more easily roll it between them, while the porcelain knob is being pressed at the bottom of the wound against the suspected foreign body (fig. 63). If it be a leaden bullet against which the porcelain is rubbed, a very distinct mark of lead is impressed on the latter, which is not easily obliterated.

This probe of M. Nélaton's may possibly deceive the surgeon, if he supposes, because no dark mark has been produced on the biscuit china, that consequently there is no bullet, as in the event of there being anything—such as pieces of cloth, paper, linen, membrane—between it and the probe, there will be no leaden mark.

Lecomte's Probe.—Dr. Lecomte has designed an instrument (fig. 64) with a view to obviate the difficulties experienced with Nélaton's probe, which not only indicates the presence of lead, but by bringing away a small portion of anything capable of being cut into, declares what it is. He has given it the name of the "Probe Nippers" ("Stylet Pince"). It consists of two fine steel blades enclosed in a canula; each blade terminates in a little cup, and when both are brought together they form a small knob. These blades are in connection with a rod and handle worked by a screw. When the knob of the probe is brought into contact with the extraneous substance, it is caused to open, and then, by pressure against it and causing the little blades to close, a small portion is carried away. Several instruments have been designed for detecting lead and other metallic substances by means of electricity.

Tailor's Explorer.—Mr. Tailor's electric explorer consists of two insulated needles. They are connected by wires with a small galvanic battery and mariner's compass. When the points of the needles touch the metallic substance the needle of the compass is deflected.

De Wilde's Explorer.—Mr. De Wilde has adapted a telegraph bell to the electric apparatus, which denotes the presence of metal by the sounding of the bell.

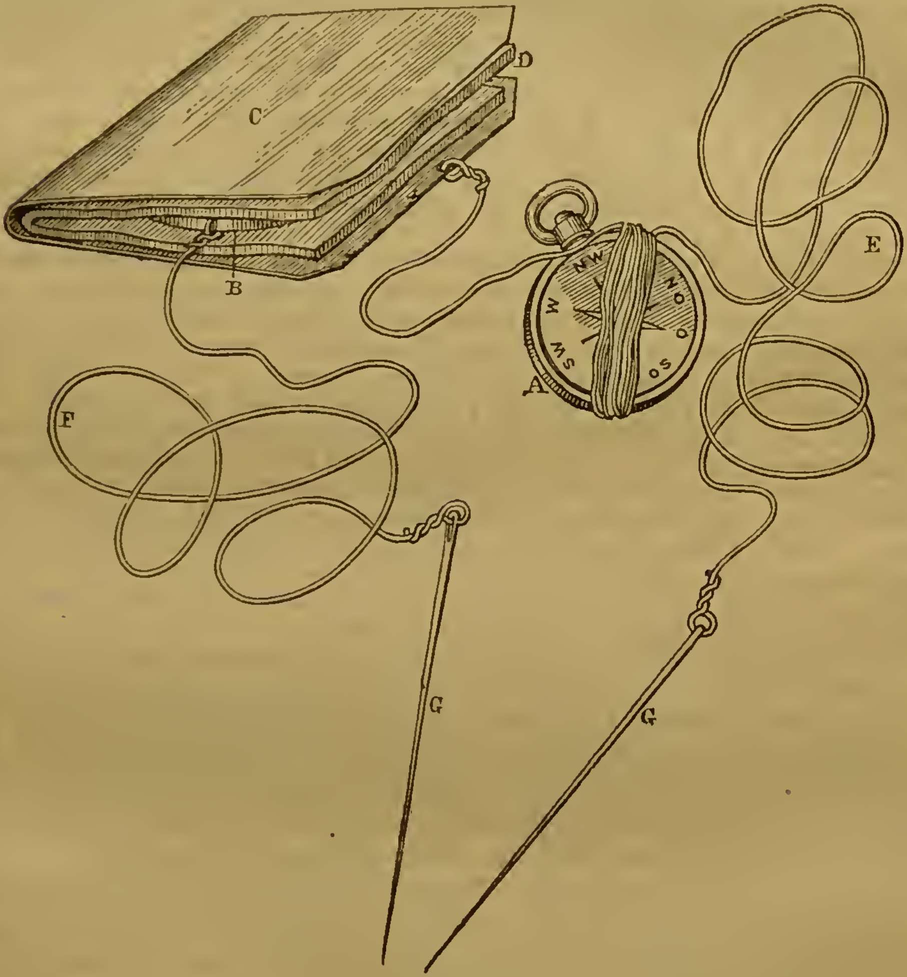

Fig. 65.

A, Pocket compass; B, Copper sheeting (a penny piece will answer); C, Plate of zinc; D, Flannel saturated with dilute acid; E and F, Insulated wires; G, Exploring needles.

Liebreich's Explorer.—Liebreich has designed an instrument somewhat similar to Tailor's, except that a galvanometer is substituted for the mariner's compass, the needle of which is deflected on the electric circle being completed.

Sir T. Longmore exhibits to his class (R. V. Hospital, Netley) an easily made electric instrument (fig. 65), so portable that it can be carried about the person of the surgeon. He describes it as follows:—The magnet of an ordinary pocket compass, which has had some turns of wire covered with thread wound round it as an induction coil, is employed for the electric indicator, while a piece of zinc sheeting bent round a small plate of copper, but separated from it by flannel padding saturated with the usual diluted acids, forms the voltaic pile. The exploring instrument is formed by two insulated wires bound together, but the points left free. These parts being connected, when the circuit is completed by contact with metal, the indication is given by movement of the magnet of the compass.

Extraction of Bullets and other Missiles.—For the extraction of bullets, fragments of shells, or other extraneous matters, various instruments have been devised. Coxetor's extractor has been found most useful for this purpose. Also a long and strong forceps with spoon-like blades, into which a bullet is supposed to slip. There is also the "tire-fond screw," and Luers' sharp-pointed forceps; and innumerable forceps designed to suit the fancies of military surgeons. Billroth speaks in favour of the American bullet forceps, its peculiarity being that it can be well opened even in the narrowest canals, and that it catches securely; he finds himself that long strong ear or nose-forceps and polypus forceps are the best. None of these can be applied without careful manipulation by the surgeon, who with his finger may be able to direct the end of the forceps towards the lodged missile, or with the hand on the outside of the limb press the bullet towards the instrument.

If the wound is not very deep, the finger (especially the little one) introduced into it may, assisted by some manipulation, hook the missile with the first joint and so extract it, the wound being slightly enlarged.

Bullets found near the skin, which have not had sufficient force to make an exit, require much care in removing, especially in the neighbourhood of a cavity, as by injudicious handling they may be pressed back into the cavity. It is therefore always best to fix the substance to be removed before using the knife, the incision made being free.

Bullets lodged in bone, which frequently happens in the spongy ends of some without causing fracture, should be cut down upon and removed. If superficially lodged, the steel elevator will be found best suited for the purpose; or if a leaden bullet is deeply impacted, the tire-fond screw already alluded to will be found convenient, or Luers' sharp-pointed bullet forceps, which is so formed as to work into the lead and take a firm hold.

In all cases of lodgment, where extraction is attempted, care must be taken not to injure the great vessels and nerves, to cause much irritation to the soft parts by extensive incisions, or to use violence.

Gun-shot Wounds of Muscular Parts.—These wounds may be divided into four:—(1) Where the missile causes no wound, but simply a contusion of the soft parts; (2) where the missile does not enter the soft parts deeply, but carries away a portion of the skin; (3) where the missile perforates the skin and does not escape (into this various other bodies may be carried, such as portions of uniform, pieces of cloth, buttons, pieces of leather, bone, &c); (4) where the bullet enters at one point, and escapes at another. Gun-shot wounds of muscular parts become painful, swell, and the usual symptoms of inflammation set in from twelve to twenty-four hours. The neighbourhood of a wound in a limb may become discoloured, depending on the amount of contusion and severity of the injury.

The discharge from a gun-shot wound is at first a reddish fluid; after a day or so it becomes darker and thicker; but much will depend on the amount of sloughing likely to take place, as if the parts are much bruised or burnt, which latter condition sometimes occurs from close shots, the character of the discharge will be modified, and separation of the dead from the living will be longer delayed. Following the separation, there will be discharge of purulent matter, which gradually diminishes. As the wound fills with granulation, this discharge may continue for an indefinite period, in consequence of retention in the wound of some foreign body, such as a piece of clothing or a splinter. It is therefore necessary at each dressing to make a most careful inspection of the wound, and remove anything which the introduction of a probe will probably detect.

The treatment must be conducted on general principles, and the remarks made on contused and lacerated wounds have an especial bearing on these injuries. "The fate of the soldier," Nussbaum says, "is in the hands of the surgeon who first attends him." The best course for a simple bullet wound in soft parts will be as directed on p. 52. But in the case of a lacerated wound, it should be washed out with a chloride of zinc or other lotion, all foreign matter should be removed and a light dry absorbent antiseptic dressing, as one of the prepared lints or wools, should be applied and kept in position by firm but even bandaging, and as much rest given as circumstances will permit. Great attention should be given to the ready escape of discharge, and free drainage is to be considered of the first importance. Should inflammation set in, warm wet boric lint should be applied under an oil-silk or guttapercha covering.

Dr. Cammerer, Surgeon-General of the German army, has published his experiences in Roumania during the last Russo-Turkish war.* "The cases came from Plevna, and had been subjected to three, four, and five days' previous transport, and arrived at the Roumanian hospitals with wounds swollen and inflamed. Yet, although an interval of seven days from the receipt of injury had occurred in most of the cases, these septic wounds were converted into aseptic ones by repeated washings out with 5 per cent. carbolic solution, and by the external application of moist jute dressings. The surface of the part injured was first washed with soap and carbolic, shaved, and again washed. All foreign bodies were removed from the wound, ill-conditioned granulation tissue scraped away, the 8 per cent. solution of chloride of zinc applied, followed by careful drainage and jute dressing externally, which was renewed at first every twenty-four hours.

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* MacCormac's *Antiseptic Surgery.*

"All the surgeons unite in stating that after an interval of fourteen days gun-shot injuries may be made aseptic. All the wounds of the soft parts, with few exceptions, did well under the treatment described. Three wounds which involved the knee, and two which implicated the elbow-joint, recovered like simple wounds of the soft parts; one of the former cases was a perforation by bullet of the condyles of the femur. In six weeks the patient was able to go about with a movable joint. In a second instance, the bullet remained lodged in the bone, but the patient recovered in a month with a movable knee-joint. The third made a similar recovery after a transverse wound through the synovial pouch. The treatment consisted in making free incisions into the articulation, washing it out with strong carbolic solution and applying moist jute."

This experience would urge the necessity of trying to render wounds aseptic after the patients reach the field hospitals, even if the first dressings have been imperfect, as they are likely to be should the number of wounded be great, and the interval prolonged between the time of injury and arrival of the wounded at the field hospitals.

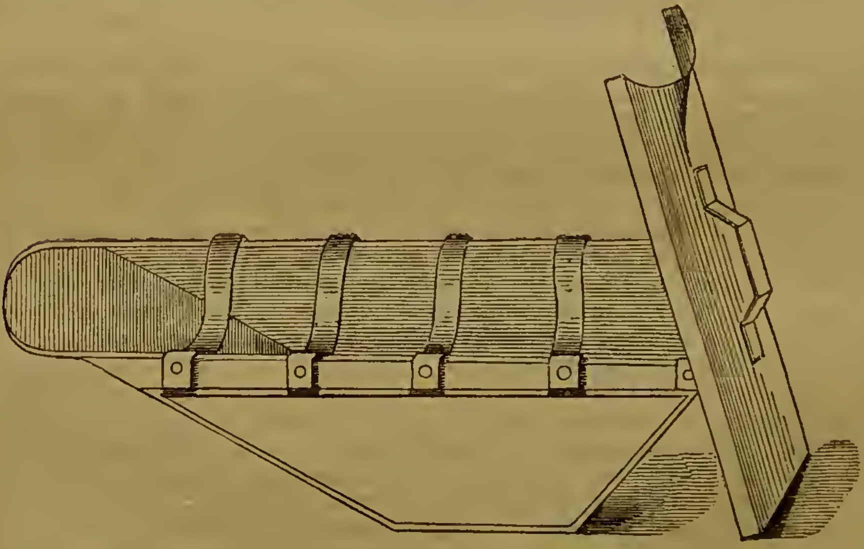

Fig. 66.—Foot Bath.

The Use of Bandages.—Hamilton, of the U.S.A., remarks:—"No part of the dressing of a gun-shot wound has more value, when judiciously employed, than a roller. At the same time, nothing is capable of doing more harm. If a roller is carefully applied to the limb at an early period, much of the bleeding is prevented, and most of the blood which does escape flows out freely from the orifices, which are left open purposely; and thus we are apprised not only of the amount of bleeding, but those extensive intermuscular extravasations are avoided."

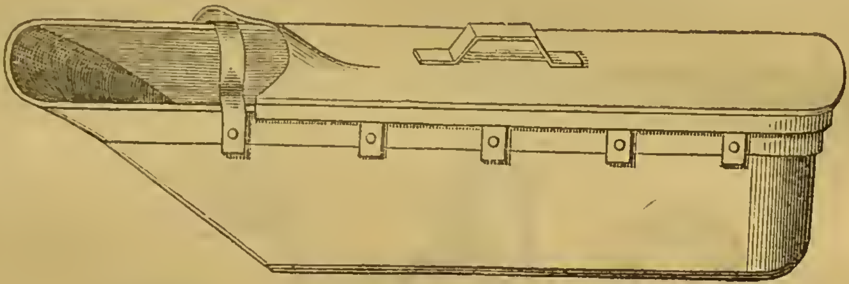

Fig. 67.—Arm Bath.

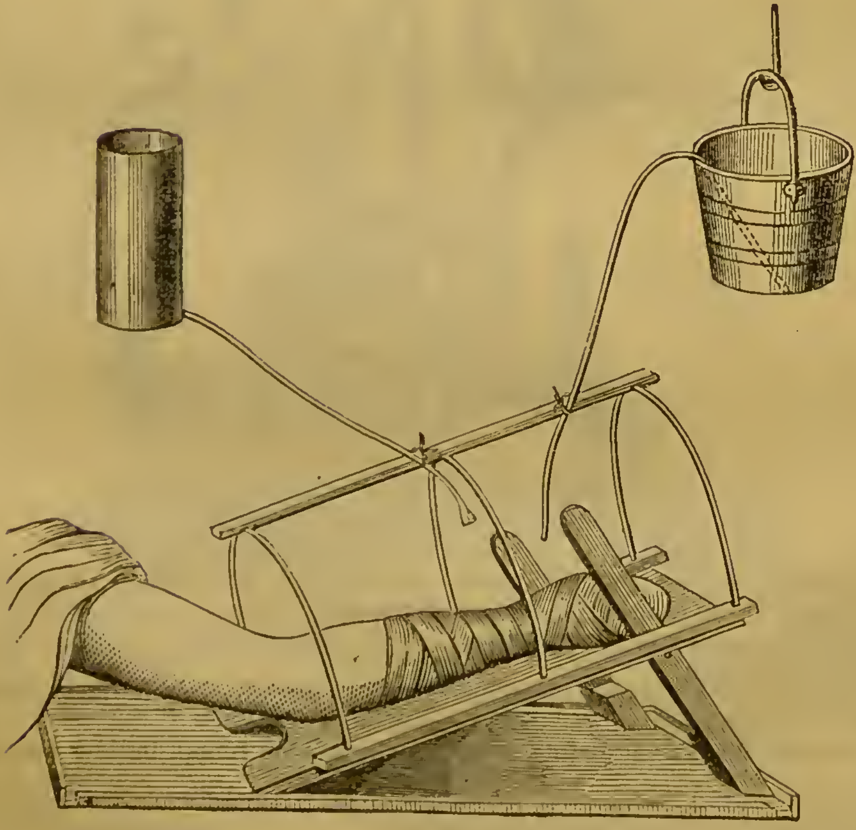

Fig. 68.

Washing Wounds.—I* beg to recommend a most excellent plan for washing or irrigating wounds, as represented in fig. 69. A gentle or strong stream of medicated water can be applied to any wound, quite doing away with the use of sponges, which are generally not numerous, and, if present, may be the means of setting up unhealthy action in healthy wounds, from having been previously used.†

With the kidney-shaped tray, as shown in fig. 69, any part of the body may be irrigated without wetting the patient's clothes or bed clothes.

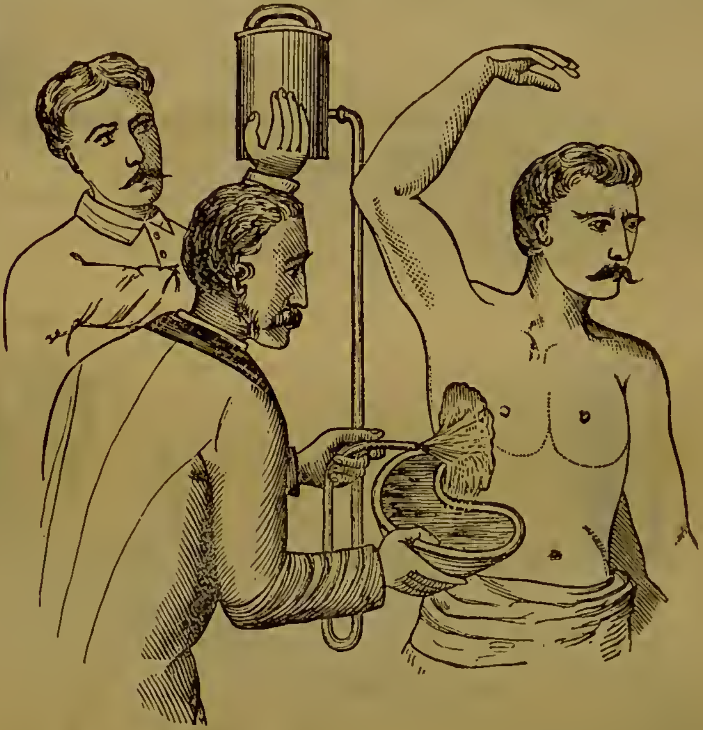

Fig. 69.

Poultices are most objectionable, and should be avoided in military hospitals. When used, they are frequently the means of assisting in establishing cases for amputation which might otherwise have turned out favourably.

Constitutional Treatment.—The constitution frequently requires looking after, the regulation of diet being essential.

Cases in which there has been much loss of blood, besides previous exposure and fatigue, require most careful feeding. It is well to remember that "beef-tea as a food ranks low, there is little in it to repair tissues, and less in it to sustain life. It falls far below milk, which furnishes force-producing material. If biscuit-powder and a little butter, with pepper and salt, be added, or fine bread-crumbs, then beef-tea is a food." A good plan is to have some sago or arrowroot jelly already prepared, and then, when the beef-tea is hot, a spoonful of the jelly can easily be added, and no further cooking is required.

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* Porter.

† This plan of irrigation was seen by the writer in the German hospitals, Versailles, during the Franco-German war, 1870–71.

"Alcohol is a readily-oxidisable form of hydrocarbon, and is one of the most easily assimilable forms of food as well as a stimulant, and very frequently it can be taken and utilised when no other form of food is available. It thus differs from other stimulants, as ammonia or ether, which are not foods, and their administration must be accompanied by food and alcohol."—*Fothergill.*

Sanitary Treatment.—The surgeon should observe strict sanitary precautions about the patient's person, bedding, and clothing, and, when it is possible, ample *cubic space* should be given to each person; for wounded, at least 1,200 feet each in buildings. In huts and tents the allowance may be less.

Ventilation of buildings is of the greatest importance; but it must be observed that, though ventilation is necessary, a wounded soldier may have too much of it, and in the treatment of gun-shot wounds *too low a temperature* may be attended by most serious consequences. During the Crimean campaign and the late Franco-Prussian war, the influence of temperature on suppurating wounds was most remarkable. In the Versailles hospitals many of them took an unhealthy action when the temperature of the wards became very low.

Delirium.—Traumatic delirium, as a complication of gun-shot wounds, is occasionally met with. The difference between it and delirium tremens from excessive alcoholic drinking, observes Sir T. Longmore, is chiefly marked by the absence of the trembling condition of the limbs.

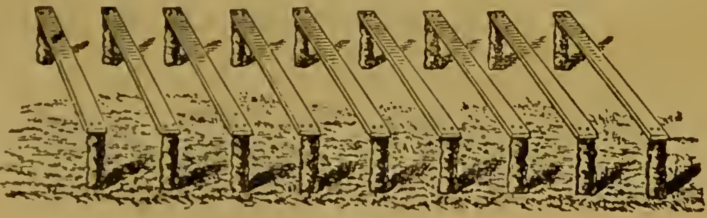

Fig. 70.

The special causes which appear to give rise to it are a lowering of the constitutional tone by fatigue, especially such as arises from excessive night duties, broken rest, watching of an anxious and responsible character, long and harassing marches, exposure to inclement weather, irregular meals, loss of blood, shock, pain, indulgence in alcohol before or at the time of being wounded, excess in strong tobacco, or an irritable state of the nervous system.

In the treatment, the surgeon should study the cause which may have led to the attack in each case, order support, if required, in the form of nutriment or stimulants, purgatives, leeches, or cold application to the head, but above all, efforts must be made to obtain sleep. The patient should be prevented from injuring himself.

Extemporised Bedsteads.—Bedsteads are most essential for the comfort and protection of patients; they may be improvised as already shown by figs. 16 and 17, or by two rows of stakes driven into the ground, rising 14 inches above the surface, and standing 10 inches asunder (fig. 70). The width of the frame must be determined by the bedding, and the number of stakes by the necessary length.

Extemporised mattresses may be made with blankets or sheets stitched together, so as to form a bag, and filled with straw, hay, dried leaves, ferns, hair, torn-up paper, or shavings of wood. Neudôrfer strongly recommends fine wood shavings as being soft and elastic.

Extemporised bed cradles for the protection of wounded limbs from the weight of bed clothes, as a means for supporting gauze to prevent the invasion of flies, or in the adaptation of tubes for irrigation (see fig. 68), are most important as part of hospital equipment. They may be constructed from hoops of small barrels, split bamboo, telegraph wire (fig. 71), or from metal bands, generally found in commissariat stores, having been a means of binding compressed hay.

Bayonet, Lance, Sword, and Arrow Wounds.—Bayonet and lance wounds come under the head of punctured wounds; sword, of incised; and arrow wounds as a combination of lacerated and punctured. The latter only will be considered here, as the former have been already alluded to.

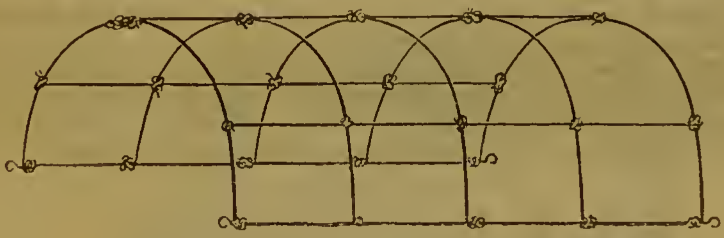

Fig. 71.

Arrow wounds are not likely to be met with in warfare between civilised countries, but arrows are still in use among savage tribes, and as the army or naval surgeon might be called upon to exercise his skill in the treatment of such wounds, the following information may be found useful:—

Mr. Hamilton describes the point of entrance of an arrow as being "indicated by a narrow slit, the margins of which are slightly discoloured, resembling very much the wound made by a small ball. The wound of exit resembles the wound of entrance, except that it is not discoloured, and is somewhat larger, "Suppuration can seldom be avoided.

"Profuse hæmorrhage, extensive abscesses, empyema, and tetanus are among the most frequent complications of these accidents, when only the external or fleshy portions of the body are implicated."

The great difficulty to be overcome in the treatment is to remove an arrow which has lodged without leaving its head.

"If the arrow has passed nearly through, so that its point can be felt upon the opposite side, the surgeon should cut down upon it by a counter incision, and extract it by that route, as suggested by Larrey; and in order to facilitate its removal in this direction, he may, as soon as the head of the arrow is withdrawn, and the end of the shaft to which it is attached can be seized by the forceps, cut off the opposite end of the shaft close to the skin by a pair of bone nippers; or if he finds the head and the shaft separated, he may withdraw the shaft on the one side and the head on the other, taking care, however, that the tedinous string (a string which attaches head to shaft) is brought out with the head, otherwise it may be left in the track of the wound. The same practice may sometimes be adopted, namely, making a counter incision to reach the head, even though the head is not felt, provided the surgeon can determine the length of the shaft, and consequently the probable position of the head.

"An arrow having penetrated bone, an attempt should first be made to extract it by rocking it to and fro in a direction at right angles with the plane of the groove which is made on the outer or feathered end of the shaft."

In the treatment of arrow wounds, remarks Professor Gross, the first indication is to withdraw the extraneous substance, and then, bleeding having been arrested, to limit the resulting inflammation by appropriate antiphlogistic measures. Long and deep incisions will often be necessary to effect dislodgment, especially if the arrow is impacted in the head of the bone, or buried at considerable depth among the muscles and aponeurosis. The best probe for ascertaining its situation is the finger.

Full anodynes should be given to prevent nervous distress and severe pain.

INJURIES OF THE HEAD.

This important and interesting subject has engaged the attention of numerous writers.

Mr. Guthrie remarks: "Injuries of the head affecting the brain are difficult of diagnosis, doubtful in their character, treacherous in their course, and for the most part fatal in their results."*

The slightest injury to the head may produce effusion, encephalitis and its consequences, plugging of the sinuses by coagula, leading to coma, paralysis, pyæmia, and death; while extensive injuries (their aspects at first threatening most serious results), such as fracture, depression, and even permanent compression, from lodgment of bullets or other extraneous substances, have been followed by no such consequences.

Classification of Injuries of the Head.—Many classifications of injuries of the head have been suggested, but it appears to the writer * that for practical purposes it will be sufficient to consider them—first, with regard to injuries of the containing parts; and second, with regard to the organs contained.

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* *Commentaries.* London, 1853. p. 286.

In the transport of soldiers or sailors with injuries of the head, the greatest watchfulness should be observed on the part of the attendants, in consequence of the liability to vomiting and convulsions.

Contusions of the Head.—These injuries generally occur in war from spent bullets, fragments of shells, or other missiles. the velocity of which has been nearly expended; or they may occur indirectly from splinters of stone, wood, &c. Whatever their origin may have been, or no matter how slight the contusion, they should be most carefully examined and watched. Mr. Liston has remarked that "wounds of the head of the most trivial character are not to be despised, or of the most severe not to be despaired of." This maxim should always be kept in view.

The treatment of simple contusion consists in the application of cold water to the part, and the administration of cathartics, light diet, no stimulants, and most perfect quietness.

Severe contusions, accompanied by a tumour, are sometimes difficult to distinguish from depressed fracture, the centre of both giving to the hand a hollow or depressed feeling. To the inexperienced these bloody tumours are a source of great perplexity, but they will in general be distinguished by their having a well-defined margin or wall, and when the hand is passed over from the sound part, it will first feel this hard wall or margin, and then suddenly experience a soft depression in the centre of the tumour.

In a fracture with depression there will be *no* defined margin or soft centre, the depression being gradual and hard to the touch; besides, there will in all probability be symptoms of compression accompanying the injury.

These tumours may give trouble by suppurating, the effused blood acting as a foreign body; but, as a rule, they become absorbed with the use of cold applications. When, however, suppuration takes place, the tumour must be incised, and free exit made for the escape of matter. Severe contusion, accompanied by an open wound, may be followed by erysipelas, abscesses, periostitis, or necrosis, as well as inflammation of the brain and its membranes.

The treatment of these contusions does not differ from similar injuries in any other part of the body; but with complications of erysipelas, abscesses, &c., the treatment requires to be most active, in consequence of the close proximity of the brain and possibility of inflammation extending.

Contused Wounds, with Fracture of the Cranium, without Depression.—These injuries but seldom occur, and, as regards the fracture, are difficult of diagnosis; a fissure through both tables may exist, without producing any alarming symptoms or external evidence.

Mr. Erichsen (*Lancet*, Jan. 5, 1878, p. 2), mentions that in blows on the side of the head where there are symptoms of compression and bulging at the seat of injury, the result of a fissure in the cranium through which blood has come, giving rise to the projection of the temporal muscle, it is right to trephine, and that the position selected should be over the course of the middle meningeal artery, which may be discovered by taking a point an inch and a half above the zygoma and an inch and a half behind the external angular process of the frontal bone; where these two points meet, the artery will be found.

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* Porter.

Furrowing of Outer Table.—There may be furrowing of the outer table without injury to the inner, this being caused by the passage of a ball across the skull, striking in such a position that it does not enter—in fact, a graze of the bone—which as a rule is followed by most unpleasant symptoms, such as inflammation of the brain and its membranes, necrosis, and abscess.

In the treatment the surgeon must be guided by the amount of constitutional disturbance and cerebral symptoms, applying local remedies such as are recommended for contusion with open wounds, subduing inflammation, and keeping the patient perfectly tranquil.

Contused Wounds, with Depression.—These injuries are, as a rule, so connected with the consideration of compression, that it is scarcely necessary to touch here on the subject. It may, however, be stated that patients have recovered from such injuries without the depression being elevated; the surgeon must therefore be guided by the urgency or otherwise of the symptoms, in deciding as to the necessity of cutting down or dividing the scalp to examine the bone, and so forming an originally simple fracture into a compound.

Sir A. Cooper, Abernethy, and Dupuytren, recommend that if the depression does not produce symptoms of compression, it is best not to interfere. Sir William MacCormac remarks on this subject: "One point regarding which opinions vary somewhat, is respecting the treatment of depressed fracture unaccompanied by symptoms, and with an external wound. Where there is no wound, he would be a hardy operator who should cut down upon a depression in the skull, in the absence of any symptoms of compression. When there is a wound, however, the case is different; but even here I question much if the surgeon ought to do more than simply remove such loose fragments as can readily be got at."

Penetrating Wounds of the Cranium generally prove fatal; but instances have occurred of recovery when the bullet or other missile has been surrounded by lymph, and the brain becomes accustomed to its presence.

When a missile has entered the brain, it is almost impossible to remove it, and an attempt to do so may also cause further injury; if, however, it can be felt superficially it should be removed.

Fracture of the Inner Table of the Cranium.—The inner table of the skull may be fractured without signs of depression, or fracture of the outer table, or detachment of the pericranium. On this description of injury Guthrie remarks that, in the great number of broken heads under his care on many different grand occasions, he has never actually known the inner table to be separated from the outer, without positive marks of an injury having been inflicted on the bone or pericranium. An operation, he says, should never be performed under the expectation that such an accident may have happened, unless it be apparently required by the urgency of the symptoms, indicating compression or irritation of the brain, which cannot be relieved by other means, and are about to prove fatal.

Fracture of both Tables.—There may be comminuted fracture of both tables, without producing the slightest symptom of compression, the bone having been broken into such small pieces that they rest loosely on the dura mater, and cause no cerebral symptoms; the treatment in such a case being cold applications and perfect quietness, with strict observance of diet, and no excess.

Fracture from Contre-Coup.—This accident, causing a fissure of the parietal bone, or fracture at the base of the skull, where it is most common, is of rare occurrency in the army. Out of 12,980 injuries of the head during the American War of the Rebellion, there were only two cases recorded of this peculiar injury. The fracture is accounted for by a heavy blow being struck against a hard resisting part of the skull, and the shock transmitted, causing the thinnest and most brittle portion, though at some distance, to give way.

This fracture is never depressed, and is very difficult to recognise. In some instances it has been diagnosed by a sensation of crepitus being given to the hand when the head has been gently moved.

The treatment should be entirely constitutional, according to gravity of symptoms, the head being placed on a soft pillow.

Fracture of the Base of the Skull.—A fall from a height, or a blow on the vertex or side of the head, may produce this description of fracture, which usually extends from the point struck across the base of the skull, not unfrequently running through the petrous portion of the temporal bone or into the foramen magnum. This is a most serious accident, and very commonly attended by fatal results; still, there are instances of persons having lived for a considerable period after such injuries. Writers on this subject have endeavoured to lay down rules or particular signs and symptoms for certain seats of fracture in the base of the skull, but unfortunately such definite information does not help one in the treatment; it may, however, assist the surgeon in forming his diagnosis.

A fissure extending through the *anterior fossa* may be accompanied by extravasation of blood into the orbit or eyelid, or there may be free hæmorrhage from the nose.

Should the *middle fossa* be implicated, there will very likely be fracture through the petrous portion of the temporal bone, with injury to the tympanum; there will then be a discharge of blood or serum from the ears.

When the *posterior fossa* has been fissured, there may be some difficulty in distinguishing the exact nature of the accident, unless the fracture passes through the petrous portion, and then there will be the characteristic signs of such an injury.

Mr. Erichsen considers that "there are two signs, the occurrence of which, separately or together, leads to strong presumptive evidence in favour of the existence of this kind of fracture. These are, first, the escape of blood from the interior of the cranium through the ear, nose, or into the orbit; and secondly, the discharge of a serous fluid from the ears, and occasionally from other parts in connection with the base of the skull." He further says: "Bleeding from one or both ears after an injury of the head may arise from any violence by which the tympanum is ruptured, without the skull being necessarily fractured. If, however, the hæmorrhage be considerable, trickling slowly out of the meatus in a continued stream, if the blood in the external ear pulsates, and more especially if the bleeding be associated with other symptoms indicative of serious mischief within the head, and if it have been occasioned by a degree of violence sufficient to fracture the skull, we may look upon its supervention as a strong presumption that a fracture of the base of the skull, extending into the petrous portion of the temporal bone, has taken place.

"Hæmorrhage into the areolar tissue of the orbit and eyelid, possibly with protrusion of the eyeball itself after, accompanies fracture of the orbital plate of the frontal bone. The ecchymosis that occurs in these cases arises from the filtration of the blood from the interior of the skull, through the fracture, into the loose areolar tissue contiguous to the injured bone. It differs remarkably in appearance from that resulting from a direct blow upon the eyelid—from a 'black eye.' In the latter case there is bruising of the skin, and the ecchymosis is in a great measure cutaneous, of a reddish-purple colour. In the ecchymosis from fracture, the hæmorrhage is entirely subcutaneous. There is probably no bruising of the eyelid, but this is tense, greatly swollen, and of a purple colour. The extravasation can clearly be seen not to be in the skin, but to shine through it."

The discharge of serum from the nose or ear, which in the latter "wells up" as quickly as it is removed, and may flow to the amount of several ounces, is generally admitted as a certain sign of fracture of the base of the skull.

Scalp wounds frequently occur to artillerymen, at the rapid practice of mounted artillery, by men being thrown off the gun carriage when going very fast, and a wheel meeting with the man's head will detach a large portion of the scalp. When such accidents occur, the wound should be treated antiseptically. The hair should be shaved and the torn scalp should be thoroughly purified with a 1 to 20 carbolic solution, allowing the solution to go into all parts of the wound, whether the membranes or brain substance be exposed or not, the parts should then be brought together by wire sutures if necessary, and drainage tubes must also be inserted. The wound should now be covered with with some dry absorbent dressing as wood wool, boric, or salicylated lint, over which a layer of cotton wool and the whole kept in place by a good bandage. The dressing should not be changed oftener than is absolutely required. Care should be taken to evacuate any abscesses that may form at an early period by adequate incisions.

Sabre wounds on the top of the head are not by any means so dangerous as those on the side. Sabre cuts will generally admit of being at once replaced, and in many instances, with the aid of a few stitches and proper supporting bandage, they adhere without further trouble. With section of scalp, cranium, and even brain, from a sabre, recovery may take place.

Erysipelas of the scalp often occurs after contusion or punctured wounds, influenced by the constitution of the patient and the sanitary state of the hospital and its neighbourhood. The treatment should be regulated by the powers of the patient and state of constitution. In the milder forms, where there is simply a reddish blush, the parts should be fomented with a warm antiseptic lotion, and covered over with boric or some other antiseptic wool. In the severer form, where there is great puffiness, without redness, the parts should be incised, the incisions being 2 to 3 inches long, and wet boric lint applied under some waterproof covering. The bowels should be regulated, and if the constitution be low, wine, ammonia, bark, and good diet, must be administered.

Injuries of the head affecting the brain have been divided into injuries from concussion and injuries from compression or irritation of the brain.

Concussion.—It is difficult to explain what concussion really is, but it appears to be a shock communicated to the nervous system, in consequence of some external injury or violence producing disturbance of the substance of the brain and interfering with its circulation.

The functions of the brain may be temporarily suspended, insensibility being slight and transitory, or it may be prolonged for several hours, or the patient may sink without recovering consciousness.

The symptoms and signs of concussion are influenced by the extent of the injury to the brain. When very slight, the feelings may be only faintness, giddiness, or mental confusion; but when the injury is severe there will be insensibility, and the surface of the body will be cold and pale; the sufferer, when spoken to in a loud tone, may answer in an incoherent manner, falling again into a state of semi-unconsciousness; muscular power is lost, the pulse feeble, the bladder and bowels act involuntarily, the pupils are contracted, breathing appears to have ceased, circulation has been suspended. This condition may last for a few minutes or hours, and is the first stage; its duration depends on the severity of the shock. In the second stage stupefaction continues, though the patient may be cognisant of being moved or roughly handled. It may be possible to rouse him, which partial consciousness is in favour of there being no compression: and when the pupils are contracted (both being alike) it is also a symptom in favour of there being no compression.

Vomiting may occur, which is generally considered a good sign, as it stimulates the heart's action, and causes the blood to flow through the vessels of the brain. As circulation is being gradually established, the pulse becomes fuller, and the surface warmer. When the injury has been more severe, the symptoms are more marked; there is complete prostration, eyes glassy, pupils may be contracted or widely dilated, surface cold; and, in fact, the patient appears moribund. These symptoms may last for hours, or merge into the severer complications of compression.

In concussion the breathing is rarely stertorous, a symptom which, if present and continual, might be considered as one of compression.

Treatment of Concussion.—In the first stage, or that of collapse, the patient should be let alone and allowed to rally; but if it is extreme or unusually prolonged, an endeavour should be made to revive the energies of the nervous system and circulation by application of warmth to the body by means of hot jars or bottles, blankets, and employment of friction to the surface. Administer warm drinks, but no stimulants, unless reaction cannot be brought about without them, and then they should be given in very small quantities, their action being carefully observed. The administration of an enema, containing some aromatic spirits of ammonia, has been recommended. Reaction having taken place, the object is to try and prevent inflammatory action. There should be perfect quietness, mentally and bodily, in a darkened room, the latter having a decided influence in preventing congestion. Cold should be applied to the head, mercurial purgatives administered, stimulants avoided, or excess in diet or excitement of any kind. Should symptoms continue, blood may be extracted from the back of the neck by leeches, or cupping. Blister to back of neck, or the insertion of a seton, have afforded relief in protracted cases.

Should inflammatory symptoms become apparent, the treatment must be most active. The head should be shaved and ice applied; gums touched by the administration of mercury as quickly as possible, either by inunction or by the mouth. Perfect quietness must still further be enforced.

During the convalescence, when the constitutional powers become depressed, small quantities of stimulants may be given, or, where there is sleeplessness and delirium, opiates give much relief.

Compression means pressure on the brain by a portion of bone, bullet, extravasation of blood, or formation of pus, or anything that may press upon, or enter into its substance, causing characteristic symptoms, some of which are as follows:—Insensibility, breathing heavy, laboured, slow, accompanied by stertor; cannot be roused; there is a peculiar noise caused by the breath being emitted from the corner of the mouth, something like a puff or whiff, caused by the velum pendulum palati hanging down in the mouth; the pulse is usually slower than is natural, but at times irregular and occasionally quick. If the shock has been slight, the countenance is flushed; but if it has been great, it will be found pale and livid. The sufferer may be convulsed and unconscious of anything about him.

The pupils appear to vary according to the part of the brain injured, and are not affected by the degree of injury. At first they are generally contracted, subsequently dilated, or one may be contracted and the other dilated; and as the disease advances, or becomes aggravated, they are immovable. The lips are usually compressed, and if an attempt is made to give fluids they run out at the corners. There may be paralysis of one side, or of one side of the face; paraplegia or hemiplegia. At first the secretions are retained; subsequently they pass involuntarily.

If the injuries have existed for a day or so, it may be necessary to diagnose between compression from extravasation, or from depressed bone, or inflammatory effusion within the skull. In cases of depressed fracture the symptoms are uninterrupted, and on careful examination the existence of an injured bone will in all probability be discovered. In cases of effusion from pus, lymph, or serum, the result of inflammation, causing pressure on the brain, symptoms of cerebral inflammation will precede the symptoms of compression.

Treatment of Compression.—A wounded soldier, suffering from symptoms of compression, appears before the surgeon. The first consideration will be, What is the cause of it? and, if that can be ascertained, What shall be done to relieve him? The cause, however, may be obscure, arising from damage within the skull, and probably beyond the reach of the surgeon. The treatment in such a case should be constitutional, and very guarded.

In cases arising from causes apparent to the surgeon, such as depression of the inner table of the skull, or depression of both tables, with lodgment of bullet or other missile, the treatment is a matter which will require the most grave consideration.

The wounded soldier should be most carefully examined, with a view to discovering the source of compression, and should the most rigid antiphlogistic treatment not relieve the cerebral symptoms, it will be necessary to consider the advisability or otherwise of using the trephine, elevator, or saw; but on this point numerous and adverse opinions have been expressed by some of the most eminent civil and military surgeons.

Mr. Hennen considers that all extraneous matters should be removed; that fractured portions of bone, if they lie loose, be extracted; and that depressed portions be elevated when it can be done without the infliction of additional violence, but to keep in view the tendency of the brain and its membranes to inflammation.

Mr. Guthrie remarks with reference to the question—What is to be done where there is breaking down and splintering of the inner table with depression? There can be no hesitation in answering that in all such cases the trephine should be applied, although no symptoms should exist, with a view of anticipating them. He considers that the danger resulting from the application of the trephine in such cases bears no proportion to the risk incurred by leaving the broken portion of the bone as a constant cause of irritation.

Sir T. Longmore says that when irregular edges, points of pieces of bone, or foreign substances are forced down, and evidently penetrate, not merely press upon the cerebral substance, or where abscesses manifestly exist in any known site, and relief cannot be afforded by simpler means, at the wound itself, trephining is a proper operation to be resorted to for effecting the necessary relief; but in all other cases harm will probably be avoided by abstaining from trephining, while benefit will be effected by simply resorting to long-continued constitutional treatment.

Dr. Stromeyer, of the German Army, abandoned the practice of trephining in 1849, though in the early part of his professional career he advocated it in complicated fracture of the skull, and after the Franco-German war—1870-71—he expressed himself as follows:—"I have tried to exclude entirely from military practice the use of the trephine as useless in some and unnecessary in other cases." He considers a state of coma from depressed skull no more as an indication for applying the trephine, than a comatose state in typhus as an indication to rouse the patient from it by any means except those which are in accordance with his general state—cold, for instance, but not stimulants. As soon as the fragments of the skull become detached by suppuration, the comatose state ceases by itself.

"The great difficulty in settling this skull question consists, then, in that some patients survive the use of the trephine, or of an early extraction of splinters, and that some recover their senses very soon after the operation. This seems to be a conclusive proof of the legitimacy of active interference. But there is no depending upon it; the patient may die just as well after having recovered his senses completely, and as experience has shown, more easily than if you let him continue comatose by not disturbing the splinters."

Surgeon J. G. F. Holston, of the U.S. Volunteers, gives his experience of operative interference in wounds of the head, in the following words:—"I will briefly state my views of trephining under the three heads of primary, intermediary, and subsequent operations.

"Primary operations are indicated—1st, when the scalp is wounded and subjacent bone broken, so as to press upon a portion of the brain that cannot be relieved in any other way; for in this case the brain has already suffered, and will suffer still further injury, if not relieved. Commonly some portion may be picked away by forceps, so as to render the operation of trephining unnecessary, as by means of the lever the depressed bone may be elevated. In these cases it has been my practice to remove all depressed bone, a little more or less making no difference. I have preferred the chisel for such removal, as the sharp edge of the chisel (fig. 72) will cut cleaner and with less irritation than the saw, the teeth of which tear the tissues, and give almost as much shock for every tooth as the chisel and mallet do at every blow.

"2nd. Where a missile, clothing, &c., had entered the brain, and by cautious sounding detected near the orifice. Where they are not so found, I should make no curious exploration of the interior of the cranium, believing that the patient may be more severely hurt by exploration than by the original injury. I should content myself in such cases by removing all extraneous spicula of bone and other detrimental matter that may be in the orifice of the wound.

"3rd. Where there is no external wound, but indirectly a large compression of bone on the brain. If symptoms of compression are gradually deepening, there can be no doubt that we should relieve the brain of pressure; in this case probably blood has been poured out from one of the meningeal arteries.

"I consider such operations intermediary as are performed on the patient before he has recovered from the immediate injury inflicted. These operations are by no means as successful as the first, and are generally done in such cases as have not had proper treatment or attention. But there is one condition, which happens occasionally, when a certain part of the skull has been struck without external wound, or without any sign of compression coming on immediately. After several days, coma begins to manifest itself; and here we have probably to deal with suppuration, which, if not speedily provided with an outlet, will sink deeply.

"Subsequent operations are such as are performed for the removal of some difficulty left behind, such as epilepsy, paralysis, &c. As regards success, I would reckon first the subsequent, next the primary, and, lastly, the intermediary operations, which are least successful of all.

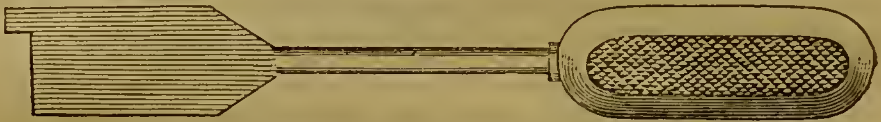

Fig. 72.—Holston's Chisel.

These are the rules which guide us in private practice, but I found in my experience in the army that they did not hold good. The injuries of the head are there so much more violent that I am inclined to think non-intervention to be the safer practice. I believe I have seen more injuries of the head recover without trephining than with, so that it is an open question with me whether trephining should not be either entirely abandoned, or left to the judgment of one specially qualified in the matter."

The opinion I * have formed on this most important subject, after some experience in military practice, is—that when symptoms of compression exist from depression of the inner table or both tables, with splintering or extravasation, it is necessary to remove the cause, if possible, by some surgical means; and, that of the instruments in use, the trephine is the most objectionable, requiring considerable force, and consequently liable to cause additional injury to the sensitive brain and its membranes. I therefore consider the use of the elevator, Hey's saw, the chisel and mallet better suited for the operation than the trephine.

When surgical interference is necessary, too much care in the manipulation of instruments cannot be observed during the operation.

There is no operation that requires greater nicety or delicacy than the removal or elevation of depressed bone or extraneous bodies from the surface or substance of the brain; but to secure success from the expedient much is required in the after-treatment, such as perfect quietness, antiphlogistic regimen, cold to the head, and avoidance of any excitement. During the Indian Mutiny, 1857, at the battle of Sultanpore, a soldier of the 10th Foot was wounded in the head, causing a depressed fracture, which rendered him insensible. The surgeon of the regiment elevated the depressed bones, and sensibility immediately returned. The sufferer was progressing satisfactorily, when the necessity for shifting camp produced great disturbance, and brought on a train of unfortunate cerebral symptoms, from which he died.

Some authorities have raised a question as to the best period for using the trephine—that is, on the first or seventh day. Mr. Guthrie expresses

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* S.-M. Porter.

himself in the following terms:—"I do not hesitate to say the first, believing the violence to be greater when done on parts already in a state of inflammation than when they are sound." Another eminent authority remarks on this point:—"Danger does not arise from early operation, but from delay." There is no doubt that if it is necessary or advisable to use the trephine or elevate the bones, the sooner the operation is performed the better, so that the cause of irritation may be at once removed.

There are certain parts of the skull to which it is recommended not to apply the trephine; for instance, over the venous sinuses, the anterior angle of the parietal bone, the course of the sagital suture, and near the base of the skull.

Sir W. Fergusson says:—"The trepan may be applied in any part of the side or upper portion of the cranium, and a knowledge of anatomy will indicate where the bones are thick, or the reverse, and also where the meningeal artery or the sinuses are in danger. The latter, I should imagine, may always be avoided; the former, if it is necessary to operate over its course, may possibly be cut across, as at the side of the cranium it often runs in a canal of bone instead of being merely in a groove. A small pin of wood in such a case would suppress the bleeding, and any escape that might happen ere this could be introduced would probably be rather an advantage than otherwise; for, generally, those who require this operation have been in robust health previously.

"The irregular thickness of the bones at different parts should be remembered, and the pressure of the teeth should be made light or heavy in proportion. At the frontal sinuses, Sir Charles Bell recommended that the inner table shall be taken out with a smaller-headed trephine than that which has been first applied; the larger external opening permitting the entire circumference of the cutting margin of the latter instrument being placed directly on the surface within. Such an operation must, however, be rarely required in this situation."

The secondary consequences of injury to the brain are—inflammation or traumatic encephalitis, deposit of pus within the organ or upon its surface or membranes.

Inflammation of the brain may occur at any period after receipt of injury. It may set in immediately, or not for many days or even weeks.

The symptoms of inflammation of the brain and its membranes being so much alike, that where one is affected the other is certain to be so, it would be impossible to draw any line of distinction.

Suppuration within the cranium has been divided into subcranial, intrameningeal, and cerebral. By subcranial is understood a deposit of pus between the skull and dura-mater. It occurs opposite the seat of injury or part struck. It may be induced by a blow on the head, causing separation of the dura-mater from the bone by disturbing vascular connection and setting up inflammation of pericranium with necrosis; or irritation caused by splinters of inner table, as in depressed fracture.

With intrameningeal suppuration there is an accumulation of pus in the subdural or subarachnoid spaces, or in the pia-mater. In the intracerebral form there is an abscess in the substance of the brain itself, caused by direct injury, by splinters of bone, bullets, or other missiles, or by contre-coup.

Treatment of Inflammation of the Brain and its Membranes.—The treatment should consist of most vigorous antiphlogistic measures, local bleeding by leeches to the temples or behind the ears, mercury, and cold to the head, the hair should be shaved, hot bottles to the feet, frequent enemata of turpentine if necessary, dark rooms, perfect quiet, and spoon diet.

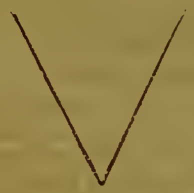
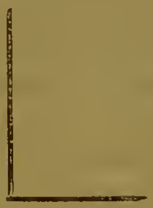
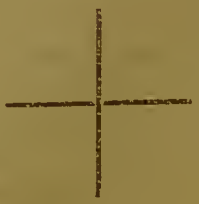
Trephining in Case of Suppuration.—Suppuration may be suspected when the inflammatory symptoms are interrupted by a rigor, or accompanied by hemiplegic paralysis on the side opposite the seat of injury. The formation of a puffy swelling on the scalp over the seat of injury has been suggested as the proper position to apply the trephine, but there would be no certainty in finding pus; the trial has, however, been attended by success.

Hæmorrhage has occurred to such an extent in injuries within the cranium, that it has been necessary to ligature large arteries. Fortunately this is a rare occurrence.

Protrusion of the Brain or Fungus, or Hernia Cerebri.—This arises in consequence of the dura-mater having been torn, or by ulceration taking place after removal of a portion of the skull.

If the dura-mater remains whole, and the wound in the cranium is small, the hernia will not take place, or if a large portion of the cranium has been removed, there will be no protrusion. Mr. Guthrie is of opinion that it is more likely to take place with a small opening than a large one. At first the protrusion may only consist of coagulated blood, appearing within one or two days after the injury, and is generally a fatal symptom. It may occur at a later period, when it will consist of brain substance and attain the size of a small orange. It is a very dangerous complication; terminates usually in encephalitis, followed by delirium and coma, consequent on inflammatory effusion within the skull.

Treatment.—The protrusion should not be shaved off, but it should be dusted with tannic acid, oxide of zinc, or powdered salicylic acid, when small pressure should be applied, but if it should become very large, this could not be carried out. In any case, the less interference the better.

Application of Trephine as recommended by Sir W. Fergusson.—"The scalp must be sufficiently opened by a , an , a , or any other incision that may be most convenient; next a perforator should be applied to make a hole in the external table, into which the central pin of the trephine should be placed, and then by rotatory motion the teeth should be carried into the bone. The external table and the diploë may be cut with bold and free movements, but caution is required when the inner plate is encountered, as also in those parts where there is no diploë, and where the thickness is irregular and uncertain: the centre pin should now be drawn above the level of the serrated edge of the saw, and again, by more cautious movements, the vitreous table must be divided. When the incision is supposed to be nearly completed, the instrument must be removed; an elevator should then be introduced, so as to raise the loosened portion, and the rest of the operation may be conducted according to circumstances. When a foreign substance, blood, or matter, is sought for under the cranium, a circular piece of bone is thus removed; but in the case of depressed fracture, only a little more than a semicircular portion requires to be cut; and this, be it observed by the young student, is taken from the sound portion of the bone, not that which is depressed; for the sole object in applying the instrument in a case of this kind is to permit the introduction of a lever to elevate the portion in fault.

"In using the trephine commonly sold, it is necessary to raise it from the groove from time to time, so as to allow the particles of bone to be brushed away; but the blade being slit up obviates this. However, towards the latter part of the operation it is proper to remove the teeth once or twice, and examine the fissure with the point of a probe, a slip of quill, or any other convenient article, so as to make sure that the dura-mater is not in danger from the skull-cap being thicker on one side of the opening than the other."

WOUNDS OF THE FACE AND ADJACENT PARTS.

Wounds of the face, like those in other parts of the body, consist of incised, contused, punctured, and lacerated.

The ratio of mortality from these wounds is not great, but they are liable to be attended by serious disfiguration and troublesome complications in lesions of the ears, nose, eyes, cheeks, forehead, tongue, jaws, teeth, and mouth, interfering with articulation, mastication, deglutition, hearing, seeing, smelling, glands, and ducts. The causes of mortality in these wounds or injuries may be classed under the heads of secondary hæmorrhage, lodgment of bullets or other missiles in bone, severe strain on the constitution from suppuration, and swallowing fœtid pus and decomposed tissues, inability to take food or masticate, neuralgia, and paralysis; the sufferers in some instances, when the bone becomes permanently diseased, being most wretched and miserable, from the continued fœtid discharge preventing them from joining the society of their fellow-creatures.

All wounds of the face show great aptitude for healing. It is, therefore, best to endeavour, with the least possible delay, to cleanse and approximate the parts, bringing them together with fine sutures, while, when a wound has been inflicted by sharp instruments, and is not deep, the skin only should be included by the silk; but in the event of the cheek being divided into the mouth, the stitches should be somewhat deeper.

Wounds implicating the Bones of the Face.—In the event of bones being cut into, separated, or displaced, they should be readjusted, and having been cleansed, the skin should be brought over them and stitched, as in the case of an incised wound.

Professor Chisholm gives an account of the plan adopted by medical officers of the Confederate Army in the treatment of wounds of the upper jaw. There was fair result, but much deformity was left in many cases. "Unless the fragments are either completely detached or but slightly adherent, they should not be taken away, but should be replaced with care, as in time consolidation may take place, and very little deformity will be left. Should some of these fragments die, they will be found loose, often as early as the sixth or eighth day, and should be removed. Cold water dressings, with an occasional dose of salts to relieve the excessive swelling, is the only medication required. The wound in the face, after careful adjustment of movable fragments, should be closed with adhesive plaster, and, with the use of cold-water dressings for a few days, the case is left pretty much to Nature."

My experience of wounds of the face during the Crimean War quite concurs with the foregoing, in adjusting and supporting the parts, and in no interference with fragments of bone or teeth unless completely detached.

Wounds of the lower jaw are acknowledged to be more troublesome than wounds of the upper jaw, and are certainly more numerous. It has been remarked by Dupuytren that they are more dangerous than the upper, but such has not been the case in late campaigns. The great obstacles to be overcome in the treatment of gun-shot wounds and extensive injuries of the lower jaw, are—1st. The difficulty of keeping the bone in proper position, in consequence of its liability to hang down. 2nd. The incessant discharge of saliva. 3rd. The difficulty of feeding the sufferer.

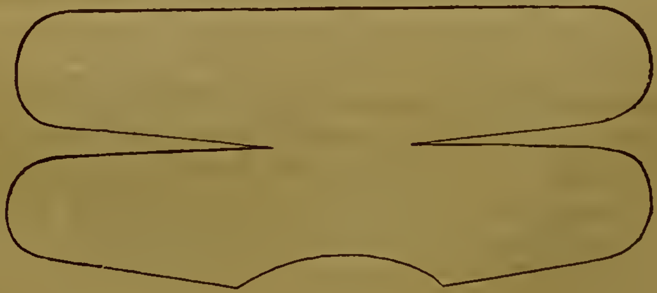


Fig 73.

After a short time suppuration sets in, and the fœtid smell (which must be relieved by antiseptics) is intolerable to the patient and his attendants.

Many ingenious contrivances have been invented for keeping the jaw in position, some of which are complicated and expensive.

On service a piece of gutta-percha, about one-eighth of an inch thick, and cut as represented in fig. 73, softened in boiling water, moulded to the jaw, as shown in fig. 74, and secured by means of a four-tailed bandage or two handkerchiefs, as shown in fig. 75, makes a comfortable appliance. It may be lined with soft lint or cotton wool, and should be applied with great care.

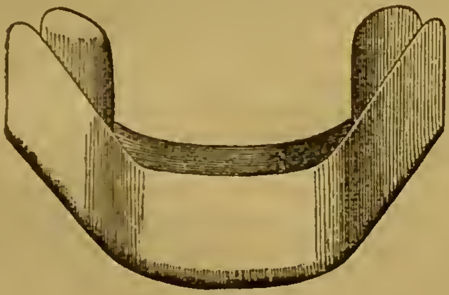


Fig. 74.

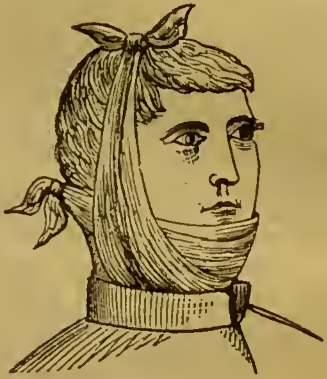


Fig. 75.

If an opportunity offers of securing two fragments of bone by fastening together contiguous teeth, it should be done by means of silver wire or silk.

The adjustment frequently checks hæmorrhage, and prevents further mischief from sharp-pointed spicula of bone, which from the hard nature of the lower jaw always exist in gun-shot wounds. The surgeon may not be in possession of gutta-percha, when he may substitute pasteboard, leather, or in fact any substance that can be moulded and give support to the jaw.

Mr. G. E. Hammond, while serving with an ambulance at the siege of Paris, had much success in the treatment of gun-shot fractures of the

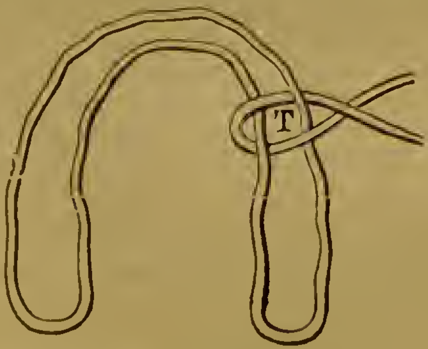


Fig. 76.—Hammond's splint for gun-shot fracture of the lower jaw.

lower jaw, by means of a framework of iron wire, as represented in fig. 76. He first approximates (temporarily) the broken bones by passing a silk thread between and around two teeth on each side of the fracture; he then takes an impression of the teeth in wax, and from it a cast in plaster of Paris. He adjusts the frame on the plaster cast, and when ready places it over the teeth, securing it on either side by wires, as shown in fig. 76. Letter T is intended to represent a tooth. The wires should be cut short, and their ends twisted in between the teeth.

This contrivance renders the jaw comparatively firm, and so solid that the patient can bite steadily on it without pain. The jaw should now be secured at perfect rest. The patient should rinse his mouth four or five times a day with rectified spirits of wine and water, and he should sleep on his side, to allow of a free discharge from the wound and mouth.

Erichsen remarks: "In fractures of the body of the lower jaw by gun-shot injury, there is great comminution and splintering of the bone, followed by copious and fœtid discharge, which being swallowed, may reduce the patient to a state of extreme debility, which may prove fatal. In these cases Dupuytren recommends cutting through the lower lip, the taking away of the splinters, and, if necessary, resection of the bone." At the assault on the great Redan, 1855, an officer received a bullet wound at the ala of the right nostril. The bullet entered the mouth, smashed most of his teeth in the upper and lower jaw, broke in the hard palate, lacerated the tongue extensively, and broke the lower jaw in several places. His condition was that of extreme wretchedness; but by adjustments of the parts as far as possible, removal of splinters, and support by means of the gutta-percha splint, he was made comparatively comfortable. The suppuration was profuse, and the wounds remained open for a considerable period, but he so far recovered as to be able to perform the duties of a field officer, having had a false palate and several teeth adapted to his mouth.

This officer was supported for several days by fluid nourishments administered through a quill passed well back in the mouth.

Fracture or fissure of the symphysis is not difficult of detection. Sir W. Fergusson adopts the following method for keeping the fragments moderately steady:—"I shape two narrow wedges of cork about an inch and a half long, and a quarter thick at the base, and sloping away to a point, one of which has been placed on each side between the teeth; and then I have affixed a wetted and softened piece of pasteboard on the chin, which has next been drawn tightly up, by means of a bandage carried from this part over the crown of the head; as the pasteboard has got dry, a kind of mould has thus been formed on the chin, which has obstructed all future movements so long as it has been kept on. The cork wedges have insured regularity as regards the teeth, and an opening has been left between the incisors, whereby the patient has been fed upon soups and other fluid nourishment. Generally, however, the wedges have become loose, and in the course of ten or fifteen days the patients have become accustomed to restrain the movements of the parts, and without taking particular pains about tightening the bandages afterwards, excellent cures have followed."

The sufferer should be supported by fluid nourishment administered by a tube passed to the back of the mouth, or by a long narrow spoon; indeed, it may sometimes be necessary to support Nature by enemata of beef tea, wine, &c.

Wounds of the Ear.—The external ear may be shot away, or cut off with a sword, or otherwise injured. Instances have been recorded by Paré and Hildanus, of the ear having been completely detached, and when replaced healing without any difficulty. Measures should therefore be adopted, on an ear being cut or injured, to replace any pieces, and secure them by means of very fine sutures, taking care to include the outer skin only, and not the cartilage.

Wounds of the orbit include the eyelids, which may be so injured as to cause much loss of tissue, and as after-consequences eversion and inversion.

The eyeball may be so injured as to cause evacuation of the humours, extravasation of blood into the eye (*hæmophthalmia*), protrusion of the iris, lodgment of extraneous substances, and general disorganisation.

The bones of the orbit may be injured, and result in inflammation of the brain or its membranes.

Mr. Hennen records a case in which a bullet was lodged in the orbit without causing injury to the eye or the bones; it was removed on the following day by a dressing forceps, was found flattened, and had caused but little irritation to the eye. Such escapes are not often met with.

Bayonets and sharp-pointed weapons perforating the thin orbital plates generally inflict such injury that they are followed by fatal results.

Incised or lacerated wounds of the eyelid and brow should be carefully cleaned, and edges brought together as far as practicable by means of fine sutures, and as quickly after the accident as possible.

Wounds of the eyeball may be divided into penetrating and non-penetrating.

Treatment of injuries to the eye which are likely to be followed by panophthalmitis should be as follows:—

All applications to the eye should be warm and soothing, such as decoction of poppy heads, or a solution of ʒi. of extract of belladonna in a pint of boiling water. A solution of atropine should be dropped into the eye twice or thrice a day. The patient should be kept in a dark room. The bowels should be freely acted upon at the commencement, and sleep should be produced and pain relieved by opium. At the commencement, salines and diaphoretics may be prescribed, but these must soon give way to quinine, bark, &c. The strength of the patient should be maintained by good fluid food with a moderate allowance of wine or brandy.—*Lawson.*

"Whenever foreign bodies are lodged in the eye, they should be extracted at all hazards. If it is impracticable to find them, the globe should be extirpated in order to preserve the other eye."

In fractures of the bones of the orbital region, it is not judicious to remove fragments, unless they are completely detached, and are acting as foreign bodies.

Injuries of the Nose.—In cases of incised wounds, the parts must be adjusted, and sutures applied in the same manner as for wounds of the ear, taking care that the skin does not curl in, which would prevent adhesion. Should the nose be broken, it is best to try and place it in its normal position; inserting in the nostrils pieces of gum elastic catheters, or plug with lint or sponge, to preserve the feature or configuration of the organ, and prevent contraction of the nasal passages and depression of the nose. These injuries are frequently complicated with violent epistaxis, which may require plugging of the posterior nares.

Wounds of the Cheeks and Forehead.—These wounds are usually the result of sword or gun-shot, and, when the parts are not completely carried away, will heal most readily if properly adjusted and secured. They have, like wounds of the scalp, the same tendency to attacks of erysipelatous inflammation; it is therefore necessary, during the treatment, to prevent the wound being exposed, and to observe strict dieting and temperance.

No matter how small a shred may be attaching a fragment of skin to the face, an attempt should be made to readjust it.

Wounds of the Parotid Duct and Gland.—Wounds of the cheek may be complicated with injuries of the *parotid duct*, and to prevent a salivary fistula being formed, Mr. Guthrie recommends: "If the duct of the parotid gland be implicated by an incised wound, care should be taken to divide the cheek into the mouth, if it should not have been already done; and to keep the incised wound open until the external one is closed. If a salivary fistula have formed externally, from inattention or otherwise, it must be treated according to the ordinary methods adopted in such cases. When a wound of the gland itself becomes fistulous and weeps, which is a rare occurrence, it will be best treated by actual or potential cauterisation, if moderate pressure should fail."

Injury of the lachrymal bones, or sac, causing the tears to run over, which misfortune may continue for life, should be treated by endeavouring to remove obstructions in the duct, and so prevent the distress which must follow from want of early care and attention.

Wounds of the tongue frequently give rise to extensive hæmorrhage, which, if secondary, or occurring several days after receipt of injury, when the process of suppuration is going on, and the tongue is swollen and painful, is difficult to check.

If the bleeding vessels can be discovered, they should be tied, and to do this the tongue must be drawn well forward, or an attempt may be made to restrain the hæmorrhage with styptics, or it may be necessary to tie the lingual artery.

Wounds of the mouth are generally in connection with wounds of the face; but they may be still further complicated with injuries to the pharynx, tongue, spinal cord, jaws, and skull.

WOUNDS OF THE NECK.

Superficial wounds of the neck require the same treatment as elsewhere, the surgeon always bearing in mind the great liability to erysipelas in these parts, rapid diffuse inflammation and infiltration.

Deep wounds of the neck, such as those produced by stabs, may be accompanied by most distressing symptoms, such as oppressed breathing, nausea, spasmodic twitching of face, paralysis of one or both arms, cough, restlessness, and hiccough.

In gun-shot wounds of the neck, it is scarcely possible to have lesion of one important structure without others being implicated; at the same time it has been generally observed that bullets and other missiles pass in and out between muscles, vessels, and nerves, and even the trachea, without causing much injury to any. This is accounted for by the soft and flexible condition of the structure of the neck offering no resistance.

Wounds of the larger arteries and veins generally prove fatal immediately, but in wounds of the smaller vessels there is frequently much difficulty in discovering whence the hæmorrhage arises, and what trunk should be tied. Mr. Guthrie quotes, with great satisfaction, the opinion of M. Velpeau on this subject: "In hæmorrhage from the neck, the mouth, the throat, the ear, or the skull, everything should be done to reach the branch of the carotid which has been wounded, rather than tie the carotid itself."

Wounds of the Larynx.—In wounds of the larynx, the parts must be adjusted and kept in contact by bandages, sutures being considered objectionable.

Should a bullet or other missile get into the larynx, it must be removed by operation, and when extensive inflammation is set up, causing infiltration or œdema, it may be necessary to open the trachea, and insert a tube to allow the sufferer to breathe.

An interesting case is given by the Surgeon-General of the American Army, where the larynx became so obstructed after a wound, that it was necessary to open it and prolong the incision as far as the third ring of the trachea; the proceeding was successful.

Should clots of blood get into the larynx or trachea, and they are not coughed up, an endeavour must be made to remove them by sucking, or by means of an exhausting pump.

Wounds in connection with the larynx or trachea, or in their vicinity, should not be closed till all hæmorrhage has ceased, for fear of suffocating the patient. These wounds may be accompanied by emphysema, causing much distress, which should be treated by small punctures, if it extends; but as a rule it will pass away when suppuration of the wound commences.

Wounds of the Œsophagus.—For wounds of the œsophagus but little can be done, Nature performing all that is required in healing; and it is sometimes most remarkable how quickly this is effected. Wounds of the œsophagus render the patient unable to swallow, without much discomfort, and in many cases not at all, when it will be necessary to give him nourishment by a gum-elastic tube introduced through the nose into the stomach, or by enemata of beef-tea, milk, gruel, and other nutritive fluids.

During the Crimean War a complicated case of bullet-wound of the larynx and œsophagus came under my* immediate care, the particulars of which may be recorded here: At the assault on the Great Redan, the sufferer having mounted the parapet, and while in the act of reloading on his knees, was shot from below by one of the enemy, who was immediately at the bottom of the parapet. He fell on his side, did not feel much pain, but could not speak. On arrival at the camp hospital, two wounds were found in the neck, the ball entered at the pomum Adami and made its exit at the anterior edge of the sterno-mastoid muscle of the right side. There was very little hæmorrhage from either wound, and no displacement of the thyroid cartilage. The patient was suffering from a frequent cough, with bloody expectoration, loss of voice, and nausea; bubbles of air appeared at every expiration at the wound in the larynx, that of entrance; and when he attempted to drink, some of the fluid came through the wound at the anterior edge of the sterno-mastoid, the wound of exit. This latter symptom continued for five days, and then ceased altogether; for twelve days the air continued to pass through the upper wound and then ceased. The cough during that time was very troublesome, and the expectoration copious, which caused much loss of rest; during the first six days there was slight emphysema about the upper wound, but it gradually disappeared.

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* S.-M. Porter.

The treatment consisted at first of antiphlogistic remedies, both local and constitutional; and lint wet with cold water was kept constantly to the wound. He was fed by means of a spoon passed very far back, containing arrowroot, milk, or tea; his diet was gradually increased after five days, and he was able to swallow bread softened in tea, rice, and milk; and, as inflammatory symptoms subsided, wine, porter, and nutritious diet were allowed. The wounds healed completely; but the voice was much impaired, being little more than a whisper.

WOUNDS OF THE CHEST.

Classification.—Wounds of the chest are divided into penetrating and non-penetrating.

The non-penetrating may be subdivided into wounds of skin, fascia, and other soft coverings of the walls of the thorax, fracture of the clavicle, scapula, sternum, vertebræ, ribs, injury of bones or cartilages, and superficial vessels.

The penetrating may be subdivided into those connected with wounds of pleura, lungs, heart, great vessels, nerves, œsophagus, and thoracic duct.

Non-penetrating wounds may be accompanied by lesions of the internal viscera, from violence, causing contusion or rupture of viscera or an important blood-vessel, and subsequently by inflammation of the pleura or lungs, giving rise to pleuritis or pneumonia, or both.

Non-penetrating wounds of the soft parts alone differ but little from wounds elsewhere, except that they are much slower in healing, due in all probability to the ribs never being at rest, and consequently the lips of incised wounds, for instance, are not kept in apposition.

In dressing these wounds, it is recommended to apply strips of adhesive plaster in such a manner that the ribs may be supported and wounds relieved from strain; this is best accomplished by placing broad strips of plaster at right angles to the ribs, and a bandage round the chest with narrow strips of bandage over the shoulders, stitched to that on the chest, with a view to keeping it in position.

Simple fractures of the several bones in connection with the chest, such as the clavicle, scapula, ribs, and sternum, must be treated in accordance with the special rules laid down for these injuries.

In compound fractures of these bones from gun-shot, where the wounds do not penetrate, much trouble and anxiety may arise from depressed spicula causing inflammatory symptoms and requiring elevation or removal, or giving rise to abscesses, or diseased bone.

Wounds of the external arteries of the chest, producing profuse hæmorrhage, should be secured at both ends, as, from the nature of the surrounding tissues, blood is apt to be extravasated or aneurisms formed.

All external wounds, at first apparently trivial, should be most carefully watched for several days, as inflammatory symptoms of the lungs or pleura may arise, and should be checked with the least possible delay.

Penetrating wounds may be complicated, in the first instance, with emphysema, pneumo-thorax, hernia of the lung, hæmo-thorax, and presence of foreign bodies, and subsequently by hydro-thorax, empyema, fistulous openings, and contractions of the chest.

In wounds of the heart and larger vessels, the result is generally immediately fatal; at the same time instances have occurred where a sufferer with a wound of the heart has lived for several days.

Symptoms of Wound of Lungs.—A penetrating wound of the chest may be accompanied by the following symptoms, which, taken as a whole or in connection with one another, may satisfy the surgeon that the lung has been wounded; but they are not proof positive that such is the case, as all may be present, and yet no wound of the lung:—Shock, sudden collapse, or fainting from hæmorrhage, internally or externally; the escape of blood and air through external wound, of pale red colour and frothy; continued issue of blood, mixed with mucus from mouth during efforts of coughing; emphysema; deeply-fixed pain in the chest; irritation of larynx and spasmodic cough; difficulty of breathing. Shock, sudden collapse, or fainting, may occur with any severe wound. The escape of blood and air through the external wound may take place in consequence of a wound of the intercostal or mammary artery by air having been drawn into the cavity of the thorax during each expiration, expelled during inspiration, and driven into the blood. The issue of blood from the mouth, mixed with air, is looked upon as satisfactory evidence of wound of the lung; but it may arise from other causes unconnected with the wound, and may therefore exist without a lung wound.

Emphysema, which was considered by older surgeons to be proof positive of a wound of the lung, is now looked upon as a complication which may be caused by the admission of air into the chest through the external wound, and not finding ready egress during respiration, passes into the cellular tissue, in the immediate neighbourhood of the external wound, and therefore cannot be considered as a diagnostic symptom of any value.

The pain in the chest, cough, irritation of larynx, and difficulty of breathing, with the continuance of blood in the mouth, or blood, *and especially mucus*, from the wound, may be considered the most reliable symptoms.

When the wounds occur in civil life, the weapon causing the injury might be procured, and a certain amount of assistance afforded by examining it, and judging of its extent by the stains of blood on it; but in war there is no such help.

It has been recommended to test the wound by holding a lighted candle opposite to it, and direct the patient to take a deep inspiration, when, if the candle is blown upon, it is a proof that the lung has been wounded.

Treatment of Penetrating Wound.—On first seeing a patient with a penetrating wound of the chest, an endeavour should be made to restore animation by the administration of beef-tea and cordials. Should reaction take place, distressing symptoms will cease; hæmorrhage may have been checked, and with a suitable bandage round the thorax, it is possible no bad symptoms will follow; but blood may continue to be poured out in the cavity of the chest, causing pressure on the lungs, and consequent symptoms of distress, or it may come through the external wound, flooding the sufferer.

Blood in Cavity of Chest.—If the blood is being poured into the cavity of the chest, the surgeon will be warned by the cold perspiration, the pallid countenance, faintings, the weak pulse, and distress in breathing. If he examines the chest, he will find it enlarged on the injured side, and the intercostal spaces bulging out. There will be dulness in proportion to the amount of the cavity filled up, and no respiratory murmur, the lung being pressed down.

Ecchymosis is laid down as a symptom or sign of effusion of blood within the chest at a late period. Valentine considers it to be a pathognomonic sign of effusion of blood. He says:—"It is very dissimilar to that which occurs after a blow or wound, and which takes place shortly after the accident, being around the wound if there be one, and extending from it. The patient also complains of pain when the bruised part is pressed by the fingers. These characters are not observed in the ecchymosis, the sign of effusion, which always takes place near the angles of the lower or false ribs, descending towards the loins. Its colour is identical with that which appears on the abdomen of persons some time after death—a bright violet (*violet très-éclairci*). It appears about ten days after the receipt of the injury—sometimes later." Should the blood come through the external wound, the diagnosis is simple enough.

Treatment for Hæmorrhage into Cavity of Chest.—It now becomes a matter of serious consideration what is the best line of treatment for this form of hæmorrhage; but before taking it for granted that it is coming from the lungs, an endeavour should be made to try and discover if the intercostal or internal mammary arteries have been wounded. And as a guide to this, it has been remarked that when there is internal hæmorrhage from the latter sources, the symptoms are more gradual than if the blood comes direct from the lungs or pulmonary arteries.

In the event of the hæmorrhage coming from mammary or intercostal arteries, an attempt should be made to tie these vessels, or otherwise close them, for which purpose various plans have been proposed, some of which may be mentioned here:—

Pass a curved needle armed with a ligature, completely round the rib, and compress the wounded artery by means of a pledget placed over orifice and included in ligature.

The employment of agarici or sponge, with continual compression by hands of successive assistants.

Sir T. Longmore describes "Desault's purse," which is a mode of compression, and is as follows:—"Place a piece of linen on that part of the chest at the wound. The middle portion of the linen is pressed by the finger into the wound, so as to form a kind of pouch. This pouch is then distended with sponge or lint pushed into it, till it arrests the bleeding. On stretching out the corners of this linen cloth, the pressure of the plug will be increased. The whole may be secured to the chest by a roller or bandage."

This method I * have used with the most perfect and permanent success, adding to the lint or sponge a little of the solution of perchloride of iron.

Mr. Guthrie considers that wounds of the intercostal arteries rarely give rise to hæmorrhage so as to require a special operation for suppression; but whenever it does so happen, the wound should be enlarged, so as to show the bleeding orifice, which should be secured by one ligature if distinctly open, and by two if the vessel should only be partially divided. The vessel is sometimes so small as to be easily twisted, or its end sufficiently bruised as well as twisted, to arrest the hæmorrhage.

It having been pretty well ascertained that hæmorrhage is from the lung, and the symptoms being urgent, what measures should the surgeon adopt? Many opinions have been expressed on this important and difficult subject.

Sir T. Longmore recommends that "hæmorrhage from the lung itself must be treated on the general principles adopted in all such cases: the administration of cool acid drinks (iced, if ice can be obtained), perfect quiet, and the administration of opium or digitalis.

"When blood has accumulated in any large quantity, and the patient is so much oppressed as to threaten suffocation, all coverings must be removed, and the blood permitted to escape by wound; the wound should even be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient be in danger of suffocation, then paracentesis must be resorted to."

Dr. Macleod, who had considerable experience during the Crimean War, says that those cases did best in which early, active, and repeated bleedings were had recourse to.

The Report of the Surgeon-General, American Army, on the treatment of chest wounds during the War of the Rebellion, is of the greatest importance; and from the vast number of cases, amounting to 20,264, the success in the treatment without venesection should be a great lesson to the army surgeon, and enable him to decide as to the proper course to be adopted in such cases.

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* Porter.

The following is an abstract of the measures used for the different descriptions of wounds:—

In injuries of the thorax, whether attended or not by breach of surface, rest, a comfortable position, and a broad bandage round the chest.

After stanching the bleeding, cleansing the parts, and removing foreign bodies, the further conduct of the surgeon must be governed by the extent and nature of the lesion. All superficial wounds should be closed, with a view to early adhesion. In extensive incisions or lacerations use sutures, but in coughing or movements these are apt to be torn out.

In penetrating wounds, some preferred to support the injured side with broad strips of plaster; this was considered a secure dressing, and acceptable to the patient. The starch bandage was used, but its application was not found convenient.

When the discharges were profuse, carded oakum was used.

In profuse primary hæmorrhage the bleeding was arrested, if possible, by ligature or compression, but when impossible to reach the source of the internal bleeding, it was considered best to close the wound and to promote occlusion of the bleeding vessel by general means.

In the general treatment, the uncomplicated non-penetrating wounds required no exceptional measures beyond restriction of diet and the means necessary to insure rest.

In penetrating wounds venesection appears to have been abandoned altogether; hæmorrhage was treated by the application of cold, perfect rest, and the administration of opium.

These measures, he says, seem to have proved adequate generally.

Dr. Chisholm's views are given in the Surgeon-General's Report. He deprecates venesection in chest wounds; even when the lung is inflamed he prefers the mild antiphlogistic and expectant treatment to the spoliative. The large success in the treatment of perforating chest wounds in the Confederate hospitals, puts forth in strong light the powers of Nature to heal all wounds when least interfered with by meddlesome surgery. Absolute rest, cooling beverages, moderate nourishment, avoiding over-stimulation, with small doses of tartar emetic, veratrum or digitalis, the liberal use of opium, and attention to internal secretions will be required in all cases; and in most will compose the entire treatment.

Among the pharmaceutical preparations employed by the American surgeons was opium, which appears to be the one on which most reliance was placed; but care should be observed in its administration, as hæmorrhage tends to increase its action. It quiets the nervous system, and indirectly moderates hæmorrhage.

Stromeyer, in his *Experiences of Gun-shot Wounds*, 1866, remarks, under the head of Wounds of Thorax, that, "with the exception of a single instance of venesection, which was at his own suggestion, there was no bleeding for chest wounds." He frequently discontinued wine and coffee, which acted as stimulants, and ordered the patient to take whey, and later on, cod-liver oil. "It is only through tranquility and prudent nourishment that the dangers of chest wounds can be avoided."

Legouest objects strongly to bleeding for wounds of lungs, as being

When there is an extensive wound of the chest, it may occur by violent efforts in coughing or in expiration.

The tumour presents a livid appearance, and if not soon returned will become gangrenous. "Or, from exposure the prolapse shrinks, becomes dry and carnified and covered with granulations, gradually diminishes in size, and finally cicatrises over, and has been known to return spontaneously into the cavity of the thorax. A prolapse of omentum through the walls of the chest may be mistaken for a prolapse of the lung. Such protrusions are to be discriminated from prolapse of the lung by their soft, fatty, reddish, and irregular feel and appearance and by the absence of crepitation."—*Lyell.**

It is resonant on percussion, and if a stethoscopé is applied to it a crackling or rubbing sound will be heard. It may be returned if seen at once, provided it has not been strangulated, or it may be removed by the knife or by ligature.

Mr. Guthrie recommends: "It should be allowed to remain, or be only so far returned, if it can be so managed, as to rest within the edges of the divided pleura, and fill up the gap made by the incision, over which the integuments should be accurately drawn and retained. The adhesion of the lung to the pleura costalis arrests the inflammation, and may prevent its progress in other parts of the cavity.

"Whenever the protruded lung has been completely returned, more inflammation has followed than where it has been allowed to remain under the precautions recommended. The protruded lung, when left uncovered and unprotected, soon loses its natural brilliancy, dies quickly, skrinks, and becomes livid, without being gangrenous. In such cases, the protruded part may be removed; but it should never be separated at its base from its attachment to the pleura costalis by which it is surrounded."

M. Legouest recommends that the tumour be allowed to fall off, and he advises dressing in the ordinary manner, protecting the parts from injury, and preventing inflammation. Above all, to repair the lesions which have favoured the formation of the rupture.

Wounds of the Pericardium or Heart.—These injuries may occur from severe blows on the chest, by puncture, stab, or gun-shot. The pericardium may be injured, and the heart escape.

When the pericardium is injured, the patient appears in a state of collapse, or death takes place immediately. The former is usually followed by inflammation, oppression, dyspnœa, great appearance of distress, small pulse, and pain at the seat of injury. The wound should be closed, if large; the sufferer kept perfectly quiet, and strict antiphlogistic treatment enforced.

Wounds of the Heart.—When the heart is wounded, the injuries may not penetrate into the cavities. Instances have been known where foreign bodies have lodged and become encysted in the structures of the organ.

In penetrating wounds the results have been immediately fatal from loss of blood and shock, but sufferers have lain for several days in consequence of the wound closing by contraction, or by the lodgment of a coagulum preventing effusion of blood into the pericardium or pleura.

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* Art. "Injuries of Chest," *Holmes' System of Surgery*, vol. i.

"It is recorded that in cases which immediately prove fatal, the wounded man appears to spring off the ground, or falls dead without convulsion or apparent knowledge of being injured. If the injury does not prove fatal immediately, there will be collapse, followed by great distress and oppression of breathing, anxious countenance, pulse very weak, pallid face. Subsequently there may be all the complications of inflammation of the endocardium.

"The external wound should be accurately closed and all escape of blood prevented, provided, in doing so, suffocation is not induced by blood filling the cavity of the pericardium or pleura, in which case relief may be obtained by allowing some blood to escape."

Wounds of the Diaphragm.—John Bell, in speaking of these wounds, remarks: "Though wounds of the diaphragm are not material in themselves, yet the diaphragm can hardly be touched but in mortal wounds, *i.e.*, wounds touching both cavities—viz., of the thorax and of the abdomen, when most frequently the stomach, lungs, pericardium, or heart are either wounded or are soon inflamed, and so drawn into disease."

The surgeon may recognise these wounds, first by the position of the injury in either chest or abdomen, and if there are evidences of a missile or weapon having penetrated; also by the following symptoms—hiccough, spasmodic or jerking breathing, pain in the top of shoulder, or loss of power in the arm. There may be nausea or vomiting, and if the liver has been injured, jaundice may occur. If the stomach or intestines have been wounded, blood will, in all probability, appear, either by vomiting or in the stools.

"A wound of the diaphragm may give rise to a hernia in the chest; it will, therefore, be necessary for the sufferer to remain in the upright position during the process of recovery, to avoid bending as much as possible; and, in the event of recovery taking place, care should be observed in eating small quantities and standing erect after meals, avoiding bending or straining, as a wound of the diaphragm is supposed never to close except under rare and peculiar circumstances. A patient, therefore, once wounded through that muscle would always be liable to hernia."

Hennen says: "Of the wounds of the diaphragm, I have never met one unconnected with injuries of one or both cavities which it divides, or in which symptoms of their being affected did not appear; although I have met with one instance where a musket ball passed along from the sternal to the vertebral connection of that septum, precisely following the curvature of the ribs. The prevention of inflammation is the leading indication of cure; but injuries are frequently found on dissection, which were not at all indicated during life by any peculiar symptom."

An operation for the relief of this hernia has been proposed by Guthrie, which, though formidable, he says cannot be compared as to danger with the incision of 12 or 14 inches long through the walls of the abdomen, which has been in some instances successfully made for the removal of diseased ovaria. The opening should be a straight incision through the wall of the abdomen, large enough to admit the hand immediately over the part where the diaphragm is supposed to be injured. It should be closed by a continuous suture throughout the skin. *The secondary causes of death* after lung wounds may arise from hæmorrhage, pneumonia, pleuritis, bronchitis, ulceration of lung tissue, empyema, pyæmia, gangrene of the lung, tetanus.

WOUNDS OF THE ABDOMEN.

Classification of Wounds of the Abdomen.—These wounds are usually divided into penetrating and non-penetrating, but some authors divide them into wounds affecting the walls, wounds extending into the cavity, and wounds or injuries of contents of abdomen. For convenience of description, the former is no doubt the best.

The danger to be contended with in all wounds of the abdomen is peritonitis; and, of course, the greater extent of injury, especially internal, the greater probability of this formidable complication.

The prognosis of wounds of the abdomen is very unfavourable, the diagnosis very obscure, and the results of treatment discouraging. Every abdominal wound should therefore be treated as if it were serious until time declares its true nature.

Non-penetrating wounds, uncomplicated, without injury of the internal viscera, require no special line of treatment. If there are incisions or lacerations, the parts should be adjusted and kept in position by means of sutures or stitches, sufficiently deep to keep the divided structures in exact co-aptation and so prevent ventral protrusions. The quilled suture

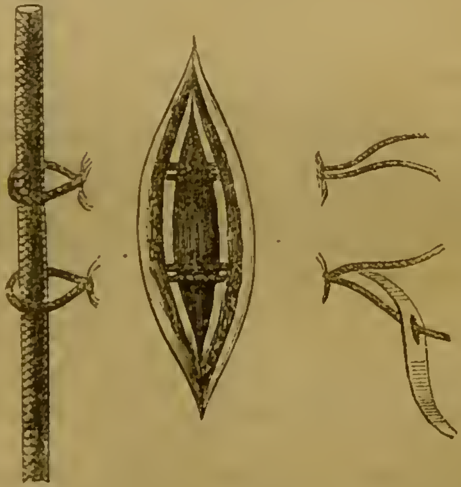

Fig. 77.—Application of the quilled suture to an incised wound.

appears to have answered the best purpose (fig. 77) in the American War. In adopting this suture, it is recommended to tie the threads in a bow-knot, or to leave the ends long if wire is used, in order to loosen the stitches if inflammatory swelling requires it. The sutures should be allowed to remain until the fourth or fifth day, and the loop of each double thread then being cut, the pieces should be withdrawn simultaneously in opposite directions. The position of the sufferer during treatment should be such that the muscles of the abdomen are relaxed by elevating the shoulders and head and flexing the lower limbs.

A bullet may strike the abdomen obliquely and pass between the muscles and the skin, or between the peritoneum and the muscles, giving rise to alarming symptoms, causing violent pain, vomiting, and general derangement, such as prolonged collapse, followed by extensive peritonitis or suppuration.

In the event of suppuration, an early opening should be made to prevent the possibility of pus perforating the peritoneum.

Should a bullet or other missile be lodged deeply in the abdominal walls, Guthrie suggests that it is often better left alone, unless it prove troublesome. This, according to the extensive experience of Mr. Otis, "is unsound;" he considers there are no other exceptions to the general rule of extracting foreign bodies, than the instances in which they are so situated in vital organs that their extraction may immediately jeopardise life. It is, he says, especially important to extract them from the abdominal walls, as they present a constant source of danger while they remain.

Complicated non-penetrating wounds, the result of contusion, may be accompanied by extensive injuries to some of the viscera or bones, and are generally the result of wind balls, explosions, blows, falls, kicks from men or horses, or the passage of the wheel of an artillery-waggon or gun-carriage over the body. Death may result in a very short time from shock, or hæmorrhage, or peritonitis, or subsequently from sloughing or abscesses in the abdominal walls. The shock in these cases is of the severest description, amounting in some instances to prolonged collapse. The writer * on a recent occasion saw an instance of an artilleryman being thrown from the limber while in rapid motion, a wheel passing obliquely over the abdomen and pelvis; he was immediately attacked by prolonged collapse, vomiting, pains, bloody urine, and great restlessness, from which he never rallied, and expired in a few hours. The *post-mortem* examination gave evidence of extensive hæmorrhage into the peritoneal cavity, it being full of large clots. There was a fracture of the left ramus of the ischium and pubes. There was no external wound of any consequence, the skin being only a little congested where the wheel had passed over it.

Ruptures of the liver are by no means speedily or even necessarily fatal; they may be and usually are so from great extravasation of blood or bile, but when this is not largely poured out, the patient may live for a considerable period, though he may eventually succumb to traumatic peritonitis.

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* S.-M. Porter.

Pain, collapse, hæmorrhage, dulness on percussion, bilious vomiting, followed by peritonitis, white stools, jaundice, and saccharine diabetes, are the symptoms usually ascribed to rupture of the liver; only the three latter are characteristic.

Rupture of the gall bladder is always fatal.

Rupture of the Spleen.—Next to the liver this viscus is represented as the most frequently lacerated of the adominal organs, but such cases are by no means always fatal. Extended lacerations are followed by profuse internal hæmorrhage, severe shock to the system, coldness of the surface, great anxiety, pain in the seat of injury, and death.

Rupture of the kidney, though well protected by its position in the loins, is not an infrequent accident. The symptoms usually present are, excessive collapse, pain referred to the lumbar région, retraction of testicle, and very likely pain in the testicle itself and low down in the abdomen; numbness in the upper part of thigh, bloody urine, frequent desire to pass water, and (should the patient survive) there will be, in all probability, infiltration or extravasation into the subserous cellular tissue, which is more likely to occur in injuries of the posterior surface, and peritonitis in injuries of the anterior surface. Infiltration is soon followed by suppurative inflammation, recognised by rigors, fever, dry brown tongue, and œdema of the parts in the neighbourhood of the wounded kidney. Should the kidney be severely contused there will in all probability be albuminuria.

Rupture of the stomach generally proves fatal from the shock alone or irrecoverable collapse. The extent of laceration, the contents and degree of repletion of the organ at the time of rupture, influence the result. Should life be prolonged, the sufferer will complain of acute and constant pain radiating from the seat of injury. Hæmatemesis is a constant symptom, followed rapidly by peritonitis.

Rupture of the intestines, both of large and small, may be recognised, as remarks Jobert, by sudden and excessive meteorism, produced by the escape of intestinal flatus into the peritoneal cavity, but this symptom is regarded by others as not being uniformly present in intestinal rupture. Should the patient live long enough, the stools will be mixed with blood, the shock and collapse will be very great; but there will be difficulty in identifying the particular part injured. The part struck will, however, be an assistance in pointing out the seat of mischief.

Emphysema of the abdominal wall may result from rupture of the intestine (with adhesion to the walls), the result of escape of flatus from the wounded intestine. This symptom is characterised by an inelastic, doughy, puffy, crepitating swelling of the cellular tissue. In wounds which to all appearance are non-penetrating, or where there is no protrusion, this symptom is considered to be valuable in proving the existence of wound of the intestine.

Rupture of the diaphragm is very difficult to diagnose. It is generally complicated, usually with hernia of the abdominal contents into the thorax. Excessive thirst, according to Dr. Wilks and Mr. Bryant, appears to be a most prominent symptom in such injuries. This injury can only occur on the left side.

Rupture of Blood-vessels.—Some examples of lesions of the larger arteries or veins, without the rupture of viscera, have been recorded.

Treatment.—In the general treatment of these injuries, the first step should be to try and restore the sufferer from the shock and collapse by keeping him very quiet, applying warmth to the extremities, and placing him in a comfortable position. Absolute rest should then be enforced, the patient not being moved or allowed to move himself. Caution should be observed in the employment of restoratives and stimulants, in consequence of their liability to cause too much reaction and induce internal hæmorrhage or peritonitis. The bladder should be evacuated with a catheter if necessary, and opium administered in moderate or full doses, according to circumstances, it being well to keep the patient under its influence for several days. The hypodermic introduction of morphia may be here used with advantage. Milk diet should be allowed, all food being given cold and in small quantities, and indeed in some cases it may be necessary to almost starve the patient.

Aperients should on no account be given till the inflammatory symptoms have subsided, and then only the mildest laxative enemata.

In rupture of the stomach, food, drink, or medicines by the mouth should be absolutely prohibited. Bandages, warmth to the surface, and leeches over the seat of pain, have been strongly advocated as circumstances may suggest.

Penetrating wounds of the abdomen, with or without protrusion or injury of the viscera, are serious, whether incised, lacerated, punctured, or gun-shot.

Penetrating Wounds without Visceral Injury.—With a small wound, such as from a bayonet or stab, it may be difficult to decide as to the existence or not of an internal injury; the surgeon should therefore be most careful not to introduce probes or other explorers, as he may inadvertently produce a most serious complication, and form a simple wound into one of great severity, as it has been proved beyond doubt that there may be deep penetration or even transfixion of the abdominal cavity without visceral lesion, the foreign body gliding between the smooth and movable organs. It is recommended that these injuries should be treated *with light dressings*, such as one of the antiseptic wools, so as to permit of oozing, rather than apply pressure and cause extravasation among the deeper tissues. The sufferer should be on the lightest diet and without stimulants; absolute rest is essential.

Should there be hæmorrhage of severe nature and the wound not sufficiently large to allow the bleeding mouth of the vessel to be seen, Mr. Pollock recommends that the wound be enlarged until the wounded vessel can be seen and secured. Pressure should never be applied for checking hæmorrhage in superficial or deep abdominal wounds on account of the blood being liable to find its way into the cavity of the abdomen, or between the muscles and fasciæ, giving rise to deep-seated inflammation and suppuration. Should bleeding have been checked, the wound should be purified and united by deep sutures.

Penetrating wounds with injury of viscera will be attended by great prostration, frequent vomiting, possibly of blood, anxiety, restlessness, and if the sufferer survive, in all probability peritonitis.

In endeavouring to form an opinion as to the part injured, the surgeon will find much help from collateral evidence; from the size of the instrument that inflicted it (if possible), the position and direction of wound, and the character of any stains which may appear on the wound or clothing.

Wounds of the liver may consist of slight groovings or divisions of the peritoneal investments only; penetrations with a single outlet; long perforations; extended lacerations; lacerations with protrusion; wounds complicated by the presence of splinters from ribs, of fragments of clothing, of balls, and other foreign bodies.

If patients escape the early danger of hæmorrhage they are liable to die of traumatic peritonitis, or from abscesses of the hepatic parenchyma. At the same time, serious injuries of the liver are not necessarily fatal. When a portion of the lacerated liver-substance protrudes at the external wound, it may be safely removed by ligature.*

Wounds of the Spleen.—It would appear that the spleen is less liable to wounds than the liver, due to its smaller size and deep situation. M. Legouest mentions that while mortal hæmorrhage or peritonitis sometimes results from lacerations, in some grave cases complete separation ensues. Protrusion is considered a favourable complication, the dangers of internal hæmorrhage and of peritonitis being apparently notably diminished by this occurrence.

In punctured wounds of the spleen it is best to place the patient on the injured side, and endeavour to avert the internal effusion of blood and consecutive inflammation by immobility. Mr. Otis recommends iced drinks, which, he says, are likely to be of benefit, both by distending the stomach and compressing the spleen, and by directly inducing contraction of the spleen.

Wounds of the Kidney are frequently associated with wounds of the liver, spleen, diaphragm, stomach, intestines, or spine. Punctured and incised wounds are uncommon, though shot wounds are not very infrequent. These wounds are very dangerous, but not necessarily mortal; unless the peritoneum is also wounded, and urine escapes into the cavity of the belly, when fatal peritonitis is almost inevitable.

When the kidney has become protruded it may be removed, as evidenced by a case reported by Surgeon-Major M. Marvaud of an Algerian regiment, in which an Algerian woman, who had been severely wounded in the lumbar region, where the kidney was drawn out of the wound, between the lips of which it remained strangulated. A silk ligature was passed around the pedicle of the extruded organ, and at the end of some weeks the kidney was separated. After two months she was discharged well. Nephrectomy has now been performed in many cases with successful results.

Wounds of the Stomach may be recognised by the position of the wound, its depth and direction, the escape of food or drink, vomiting of blood, pain, faintness, thirst, singultus, tympanitis, pallor, cold extremities. The extravasation of the contents of the stomach is probably the only pathognomic sign of the division of its walls. Much difference of opinion exists as to the proper rules of practice in punctured wounds of the stomach, *even when it protrudes* at the external wound. If the opening is somewhat small, it is recommended it should be closed with the interrupted suture by means of a delicate needle and fine gut. In more extensive wounds, the continued suture, or one of its numerous modifications, may be applied. The danger of a wound of the stomach, remarks Mr. Pollock, is greatly lessened, when its contents escape externally.

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* *The Medical and Surgical History of the War of the Rebellion*, part ii., vol. ii., p. 147.

The treatment must depend on symptoms ; no interference should be permitted with the external wound, if the contents are passing through it. The stomach should be kept empty, and the patient nourished entirely by enemata of beef tea or soup. If there be no evidence of escape of the contents, but if it be suspected that the latter have passed into the peritoneum, as evidenced by the severity of the pain and other symptoms, no treatment is available to save life ; and in such a case we have only to endeavour to mitigate suffering. Instances have occurred of wounds of the stomach terminating in gastric fistulæ.

Protrusion of the Intestine.—If the wound in the abdomen has been made by a cutting or lacerating instrument, or by a round ball or rifle bullet, it is generally followed by protrusion of some portion of the contents of the abdomen, the omentum, mesentery, or intestine being most usual. The protruded mass is always very large in comparison with the aperture from which it escapes, and is held very tightly by the lips of the wound. If left unreduced, the mass will soon become gangrenous from pressure; it should therefore be cleansed in warm carbolic lotion, 1-20, and returned into the cavity of the abdomen, after which the wound is to be closed by sutures which should include the peritoneum as well as other tissues. Mr. Erichsen suggests that the abdominal muscles should be relaxed by bending the thigh upon the abdomen, when the protrusion may be pushed back by steady pressure upon it, but no force should be employed. If the parts cannot be reduced, the aperture through which they have escaped must be enlarged in the direction upwards. In replacing them, care should be taken that they are fairly put back into the cavity of the abdomen, and not pushed into the sheath of the rectus or in front of the peritoneum. The surgeon should not push the finger into the abdomen, but simply replace the protruded gut or omentum, and allow it to remain in the neighbourhood of the wound, to which it will contract adhesions.

"If omentum protrudes, when it can be returned, do so after thorough purification, and then stitch the abdominal walls, including the peritoneum, close together. Where, from adhesions or other sufficient cause, this cannot be done, or where the omentum is very dirty, it would be the safest practice, especially in the case of a person with strong muscular parietes, to stitch the deepest part of the omentum to the deepest part of the wound, cut off the remainder, and close the skin over all."—*Cheyne.**

In returning protruded masses of omentum or intestine, great care and gentleness are required ; if both are protruded, the latter should be pushed back first, and if strangulated, the cause of constriction must be removed.

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* *Antiseptic Surgery.*

Gangrene of Protruded Intestine.—Should the protruded part of an intestine become gangrenous from continued contraction and exposure, it should not be reduced, but an incision should be made through it, or the gangrenous part removed, so as to clear away fæces and admit of an artificial anus, by attaching the cut edges of the bowel to the wound in the abdomen. This operation is not dangerous if deferred until adhesions at the orifice have formed a barrier to the extension of inflammation.

Wound of Protruded Intestine.—Protruded intestine may be punctured, incised, lacerated, or completely divided. These are very formidable injuries to deal with, as it is clear that the escape of fæculent fluid, though of the smallest quantity, may give rise to violent peritonitis. Some difference of opinion among surgeons has existed as to the proper method of dealing with the wounded gut. Scarpa and S. Cooper were opposed to the practice of stitching it, on the ground that it does not prevent extravasation, and that the stitches produced irritation by acting as foreign bodies. On the other hand, Guthrie, Travers, Longmore, Bryant, Pollock, and other experienced surgeons advocate the practice.

Guthrie recommends, " when the wounded bowel protrudes, or the external opening is sufficiently large to enable the surgeon to see or feel the injury by the introduction of his finger, there should be no difficulty as to the mode of proceeding. A puncture or cut, which is filled up by the mucous coat so as to be apparently impervious to air, does not demand a ligature. An opening which does not appear to be so well filled up as to prevent air and fluids from passing through it, cannot usually be less than two lines in length, and should be treated by sutures. When the intestine is more largely injured, in a longitudinal or transverse direction, or is completely divided as far as, or beyond, the mesentery, the continuous suture is absolutely necessary."

Sir T. Longmore recommends that when a protruding intestine is found to have been opened by a projectile, or to be gangrenous, the part so wounded should not be returned, but steps should be taken to try and form an artificial anus so as to imitate the usual means of a natural cure when recovery follows a gun-shot wound with penetration of intestine.

Mr. Travers advocates the stitching up of a wounded intestine, and bases his opinion on the result of experiments which proved that when a wounded gut was sown up and returned into the abdomen, the lymph was effused on the external surface of the bowel consequent on such an operation, and the stitches rapidly cut their way into the interior of the bowel, and were passed away into the stools.

Mr. Pollock, in speaking of these wounds, observes: " A wound of protruded intestine or stomach, if small, should be secured by ligature; if large, by sutures; and the protruded viscus returned into the abdomen. The former lesion may terminate in recovery, but wounds amounting to direct division of the canal are irreparable, unless artificial anus be established."

From the great experience obtained during the American War of the Rebellion, it was found that in all punctured and incised wounds of the intestinal canal attended with protrusion, the safest practice consisted in closing the intestinal wound by suture, and reducing the protruded viscus, unless its structure was irretrievably disorganised, and the adoption of the alternative of establishing a preternatural anus was compulsory.

Wounds of the intestines without protrusion are of most serious nature, their effects depending greatly upon the condition of the viscus when wounded. Should the stomach, intestine, or bladder be distended extravasation into the abdominal cavity will almost to a certainty take place, which will be followed by shock and diffuse peritonitis; but if these organs are not distended, the injury may be very limited, giving rise to local inflammation, and in all probability sealing of the wound. Mr. Otis considers that in wounds of the small intestines, when there is any danger of extravasation, the external wound should be enlarged and the wound in the intestine closed by suture. Wounds of the large intestine, he considers, often do well without interference, and in these wounds enteroraphy will seldom be requisite, unless the wounded colon protrude; yet he says there are exceptional cases, in which extending the external wound and sewing up the rent in the gut is the best and only means of preventing extravasation.

Method of stitching Wounded Intestines.—Numerous stitches have been advocated by different authorities.

Ballingall recommends M. Lembert's plan of operation for wounds of intestine:—"A small stitch, including only the peritoneal coat of the intestine, is to be taken up on one side of the wound, at the distance of a line or two from its edge; the needle is then carried across the wound, and a similar stitch taken up on the opposite side at the same distance from its edge; in this way a number of ligatures are introduced at the distance of a quarter or half an inch from each other (fig. 78); and when these come to be tied, the wound is completely closed, the serous surfaces of the peritoneal coat on either side of the incisions are brought into contact, and the lips of the wound are left projecting into the intestinal tube" (fig. 79).

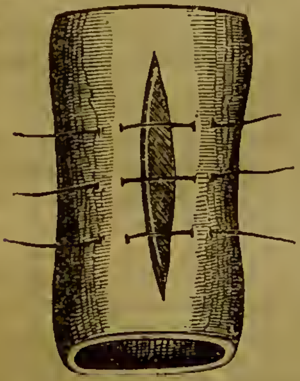
Fig. 78.—Interrupted sutures of Lembert.

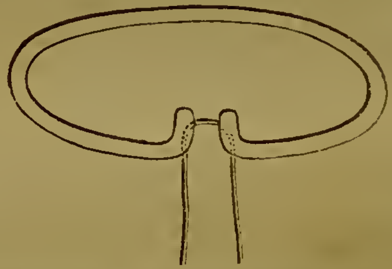
Fig. 79.—Shows the inversion and approximation of the serous surfaces.

Mr. Erichsen recommends that in making stitches "they should be introduced by means of a fine round needle armed with sewing silk, in such a way that the peritoneal surfaces on each side of the wound are brought into contact. Adhesion takes place slowly between these, the wound in the other structure of the gut filling up by plastic deposits" (fig. 80). He considers it difficult to follow out the plan proposed, of the needle only penetrating the peritoneal and areolar coats, no muscular tissue being taken up, and is of opinion that the safer plan is doubtless to carry the suture through the whole thickness of the gut, bringing the stitches out at about one-sixth of an inch from the edge of the cut in such a way that the serous surfaces are drawn into apposition. The ends of the stitches should be cut short close to the knot.

Having given the opinion of some of the most eminent authorities on the subject of a wounded and protruded intestine, a summary may now be made as to what the surgeon should do. The parts should be thoroughly cleaned with a little tepid carbolic lotion (1-20, 1-30), and if there is an incised wound, its edges should be brought together by means of uninterrupted or Glover's sutures. The intestine is then to be returned with great care to the abdomen, provided there be no constriction; but should such exist, the outer wound is to be enlarged.

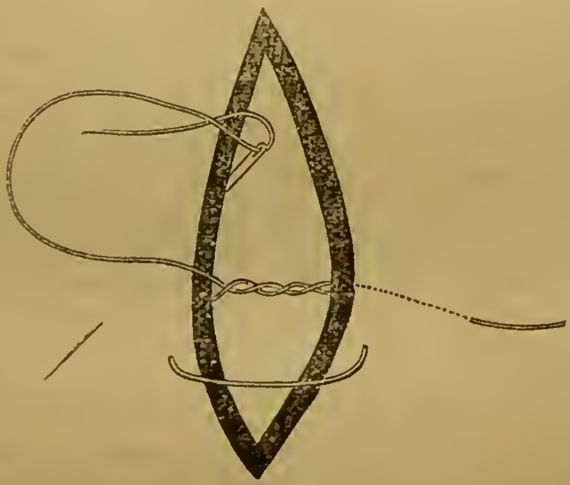

Fig. 80.

The wound of abdomen must be treated as if the wound of intestine did not exist.

In the event of the wound of intestine being gangrenous or extensively lacerated, so that the edges cannot be brought together, the course to be adopted is to stitch the upper portion of the intestine to the abdominal wound, with a view to the formation of an artificial anus. The position of the patient in all wounds of the abdomen is of the greatest importance; it should be so that the muscles are relaxed. The diet should be of the mildest description; no stimulant of any kind whatever should be given. The topical treatment should be bland and soothing, and the surgeon must ever be on the watch for the approach of diffused peritonitis, which is the great danger to be apprehended in all injuries of the abdomen. Wounds of these parts are always followed by peritonitis, as part of the process of healing; but then it is local and confined to the immediate neighbourhood of the injury. But diffuse septic peritonitis is more serious; it is accompanied by tenderness all over the abdomen, especially at the wound, tympanitis, vomiting, hiccough, hard, quick, and small pulse, great heat of skin, and anxious countenance. This traumatic peritonitis is attended with exudation of serum or ill-conditioned lymph, and will run its course in a very short time.

Treatment of Peritonitis.—In the treatment of peritonitis, the surgeon must be guided by the condition of the patient. If he is young, strong, and healthy, it may be necessary to apply numerous leeches over the abdomen, followed by warmth in the form of poultices or fomentation.

In the American War of the Rebellion, as far as can be learned, in the armies on either side, venesection was abandoned in the treatment of peritonitis, even more completely than in wounds of the chest. Opium should be freely given, and its influence closely watched. It may be administered hypodermically, when rejected by the stomach, or by means of suppositories. Calomel with the opium may be administered either at short or more lengthened periods. The influence of the opium on the sufferer is a guide to continuing it or not. The diet should be just enough to support nature, in the form of barley water, whey, light drink, ice, or cold water at first, and then the blandest of nutriment, such as milk, sparingly allowed. Circular bandages have been recommended. The patient should not be moved or move himself, and, as a distinguished authority observes, men with penetrating wounds of the abdomen should be permanently treated as near as practicable to the spot where they fall. Every rod, he continues, they are transported adds to the formidable peril they have already encountered.

The extreme fatality of acute diffused peritonitis, especially of that form due to perforation, has led to the proposal that acute peritoneal inflammation should be treated by the same methods that we successfully apply to other acute inflammations—viz., by free incisions and drainage, and Mr. Treves suggests the use of abdominal section in the treatment of certain cases.*

Extravasation of blood into the abdominal cavity may arise from injuries of the aorta and its branches, lesions of the vena cava, of the portal vein and its ramifications, or from wounds of the viscera. In the treatment of intra-abdominal hæmorrhage the surgeon may adopt absolute immobility, occlusion of the external wound, and application of refrigerants; together with cold acidulated or saline drinks, opiates or digitalis, veratrum viride or gallic acid.

When internal bleeding proceeds from vessels of the abdominal walls, they should be secured by ligature, and searching for them by introducing the finger into the wound in the abdomen, may lead to their recognition.

Guthrie considers that if a punctured or incised wound be small, and the extravasation or effusion within the cavity seem to be great, the wound should be carefully enlarged and the offending matter evacuated.

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* *Year Book*, 1885.

*Yes, Abdominal section is the thing now, in all penetrating wounds, c̄ injury to gut.

When effused blood forms a circumscribed tumour, giving rise to inflammatory products, it will be necessary to evacuate it.

Foreign bodies lodged in the cavity of the abdomen are not of uncommon occurrence, and instances have been adduced where they have become encysted and ultimately eliminated by stool. The act of exploring shot wounds of the belly for lost missiles is decidedly objectionable: at the same time, there are authorities who consider that, when practicable, they should be removed.

The operation of laparotomy has now become so established that it would not seem more risky to perform it for the purpose of removing a foreign body as a leaden bullet from the cavity of the abdomen, or to sew up a wounded intestine, than to do so for an ovariotomy or an intussusception. "The causes of danger in this operation are chiefly three—septic peritonitis and septicæmia, shock, and hæmorrhage. It is, moreover, to be remembered that the peritoneum becomes inflamed under the same conditions as other tissues, and has no peculiar tendency to inflammation of its own."

Sir W. MacCormac remarks* :—"In future wars we may feel certain that in penetrating abdominal wounds patients will not be left to die without an effort being made to save them. The abdomen will be laid open, the wounded intestine sutured, the cavity cleaned out, and treated subsequently as an ovariotomy." At the same time, such an operation is not to be lightly undertaken, for, as Sir T. Longmore points out, "patients who are subjected to ovariotomy, &c., are not labouring under the profound shock which usually accompanies all gun-shot penetrating abdominal wounds in warfare." Again, all the hygienic arrangements of the operating ward cannot be expected in the field.

If undertaken, the temperature of the room should not be cold; the bowels should be emptied, and the bladder also; the greatest care taken about the cleanliness of hands, instruments, sponges, &c.; the sponges should be counted before and after the operation, and all hæmorrhage from the abdominal walls should be arrested before the peritoneum is opened. Protruded intestines should be held back by lint soaked in warm (1–40) carbolic lotion. The abdomen should be cleaned with sponges squeezed dry one after another until they return quite clean. Lawson Tait, however, prefers frequent washings until the water returns clear to sponging. In closing the wound, the deep stitches of carbolised silk must include the peritoneum. All the deep stitches must be passed before any are tightened. After the wound has been brought together finer stitches may be put in to bring the edges of the skin in contact. If it is thought necessary to drain the abdomen, a large tube of india-rubber or glass is passed into the most dependent part of the cavity, and brought out at the lowest angle of the wound. The dressing should consist of some efficient antiseptic material, which is most conveniently kept in place by a broad band of strapping. After most abdominal operations, the patient should be kept without food from twenty-four to forty-eight hours. A small quantity of iced soda-water or barley-water may be given to allay thirst. If there is reason to believe that the peritoneum is becoming distended with fluid, the patient may sometimes be saved by opening one end of the wound and inserting a tube.—*Erichsen.*

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* In his work, *Antiseptic Surgery.*

Colotomy.—Mr. Christopher Heath recommends the following operation (*British Medical Journal*, December 1, 1877):—Place the patient on the right side, with a pillow under the loin, in order that the left loin may be thrown into greater prominence. Then measure a point midway between the anterior and posterior superior spines of the ilium, and from that point draw a vertical line upwards to the last rib. This line will give you the position of the bowel. Then make an incision 4 inches long, somewhat obliquely, between the crest of the ilium and the last rib, half of the incision being on each side of the vertical line marked out. It should be slightly oblique, running parallel to the last rib. In making this incision, you divide the skin, subcutaneous fat, the external oblique and latissimus dorsi muscles, thus exposing the internal oblique; you now expose the fascia lumborum, which you carefully divide on a director. You have now exposed the loose fat about the kidney and colon in the anterior part of the wound, and the edge of the quadratus behind. The bowel may be found just in front of the quadratus lumborum, and should be brought into the wound with the hooked finger; its posterior surface should be exposed. With a large curved needle you pass a stout silk thread through the skin to one side of the ink mark across the bowel, and again through the skin at a corresponding point on the other side of the mark, repeating the proceeding at the other end of the incision. Thus, the colon is held to the margin of the wound before being opened. A transverse incision is now made into the bowel between the threads, and, the finger being introduced, the two loops can be drawn out, and, on dividing them, you have four threads to fix the bowel to the wound only requiring to be tied. The rest of the incision on each side of the bowel is then closed by ordinary sutures, and the operation is completed.

WOUNDS AND OTHER INJURIES TO THE SPINE.

Injuries of the spinal cord may be divided into concussion and compression, the same as injuries of the brain, to which they bear much resemblance.

Concussion may occur directly or indirectly, as, for instance, from a blow, or by falling from a height on the buttock.

Mr. Alexander Shaw says, in his remarks on Concussion of the Spinal Cord:—"But certain cases of injury of the back are met with in which paraplegia has directly or shortly afterwards occurred, and in which, upon examination of the spine after death, no fracture, displacement, extravasated blood, or anything capable of compressing the cord, can be discovered. The explanation therefore given is, that the spinal cord had been damaged by concussion."

The following symptoms of concussion are usually present from direct violence:—Pain at the seat of the injury, vomiting. If the phrenic nerve is irritated, hiccough, and feeling of constriction round the body will be present. When the vagus nerve is irritated, there will be a sense of suffocation, with probably irregular action of the heart and distressing vomiting. There may be loss of power over the sphincters of both bladder and anus, with incontinence or retention of urine or fæces, or the bladder only may be affected.

In concussion from indirect violence, the symptoms are sometimes insidious and protracted, and do not show themselves until the more apparent injuries are recovered from. For instance, after an explosion men who have been badly burnt or otherwise obviously injured, after recovery from these injuries often develop a secondary train of nervous symptoms, which quite unfits them for the performance of their duties, and renders them utterly miserable and helpless. They become nervous and timid, and different from their former selves.

Treatment.—In treating these injuries, absolute rest to the parts is the principal object to be arrived at.

Mr. Erichsen, who appears to have made a special study of this subject, says :—"The importance of rest cannot be over-estimated. Without it no other treatment is of the slightest avail." He considers it of the utmost importance to insist upon absolute and entire rest, for this reason, that not infrequently patients feel for a time benefited by movement, but nothing can be more erroneous than this idea, for the patient will invariably be found to fall back into a worse state than had previously existed. With this rest, which should be in the prone position, he recommends chloral to procure sleep, and the bromide of potassium to allay the irritability.

Counter irritation may be applied to either side of the spine, and, if there are inflammatory symptoms present, ice may be used with advantage. Subsequently tonics in the form of iron, strychnine, and cod-liver oil.

Compression of the spinal cord may be induced by injuries to the vertebræ, such as fractures, dislocation, penetration by gun-shot wounds, or by extravasation of blood or pus. The symptoms produced depend much upon the position of the injury.

These injuries are of the greatest importance to the patient, as much will depend, as regards the future of the sufferer, on the amount of damage inflicted.

In dislocations or fractures without an external wound, the symptoms which generally present themselves are shock to the nervous system, profound collapse, pain in the seat of injury, tumefaction of injured part, unevenness or depression of projections in the process of the vertebræ, and paralysis of the body below the level of fracture.

Paralysis in Injury of Spine.—The extent of paralysis differs according to the part of the spinal column injured, as, for instance, fracture or dislocation in the cervico-dorsal region, all the body below seat of fracture will be paralysed, and if the injury to the cord has been above the origin of the first dorsal nerve, which joins the axillary plexus, some impairment in the motion and sensation of the upper extremities will be discovered ; but the principal danger overhanging the patient is connected with his respiration.

Fracture and dislocation in the dorsal region, between the tenth and fourth vertebræ, causes complete paraplegia. The bladder and rectum will be paralysed, and bed sores are sure to form.

In fractures or dislocation of the lower lumbar vertebræ, there may be no paralysis, if the injury is below the second lumbar vertebra, in consequence of its being below the level of the spinal cord, which terminates there.

Injuries of the spinal column, above the origin of the phrenic nerve, are attended with instant death.

Treatment.—No attempt should be made to reduce a fracture or dislocation of the spine. Means should simply be adopted to support nature by means of nourishing diet, to prevent sloughing bed sores by placing the sufferer on a water bed or soft mattress, the urine should be drawn off regularly, and great cleanliness observed.

The bowels may be moved involuntarily at first; but afterwards be constipated, when they should be relieved by enemata.

In penetrating wounds, where the vertebræ may be driven in on the cord, splinters, articles of clothing, and muscular tissue may have to be elevated, extracted, or removed. With a view to enable the surgeon to do this, the trephine, elevator, or small saw may be had recourse to.

The Trephine in Injuries of the Spine.—Sir T. Longmore, in speaking of the use of the trephine in these injuries, says:—"In injuries of the vertebral column and spinal cord occurring in military practice, the mischief is usually so complicated and extensive, and the medulla itself so bruised, that the cases must be very rare, indeed, in which the operation of trephining, if justifiable in any case, can offer the slightest prospect of benefit." He mentions that M. Baudens extracted by means of an elevator a ball which had lodged in the eleventh dorsal vertebra, and was causing compression with complete paraplegia. The paralysis disappeared immediately after the extraction of the bullet; but tetanus came on four days afterwards, and proved speedily fatal.

Sir C. Bell condemned trephining the spine, but the measure has its advocates.

The operation is one attended by considerable trouble and difficulty, and when completed it may be discovered that the cause of compression is out of reach, being displacement of a body of a vertebra instead of a depression of an arch or process.

The course recommended to be adopted in applying the trephine is first to make an incision in the line of the spinous process about an inch deep and 6 inches in length, or according to the extent of the injury, through the skin and muscles, which should be cleared away on either side of the spine, and the bony structure exposed to admit of the trephine being applied. Before using the instrument, loose pieces of bone should be elevated and removed, care being taken not to push any spicula into the spinal cord.

Hey's saw and a cutting pliers will be found most useful in dividing processes or arches.

Mr. Shaw considers that, "in injuries of the spine, except in those cases of fracture high in the spine, in which respiration has been interrupted, the paralysis is not the direct cause of the fatal termination."

In cases of fracture generally, "the chief dangers to life arise from extensive and exhausting sloughs and bed sores, morbid conditions of the bladder and urinary organs generally, and in a certain degree derangement of the bowels. These are indirect effects of the paralysis. But if they be overcome, the mere loss of motion and sensation in the limbs, and inability to control the action of the bladder and rectum, will destroy life, or be inconsistent with the patient enjoying good health. The principal aim in treatment ought to be to avert those bad consequences, and endeavour to preserve life without incurring formidable risks in expectation of getting rid of the paraplegia."

INJURIES TO AND WOUNDS OF THE PELVIS.

Classification of Injuries to and of Wounds of the Pelvis.—Mr. John Birkett arranges injuries of the pelvis in the following manner :—

I. Contusion involving the soft parts in contact with the outside of the pelvis.

II. Fractures and dislocations of the bones forming the pelvis.

III. Injuries of those organs in relation with the pelvis which are connected with the functions of—

A. Micturition ; B. of Generation ; C. of Defæcation.

As compared with penetrating wounds of the abdomen, wounds of the pelvis are far less fatal, due probably to the fact that in wounds of the belly the limits within which the reparative efforts of nature can be assisted by art are very limited.

Contusions of the Pelvis.—Contusions of a slight form require no difference in their treatment from similar injuries in other parts of the body. At the same time, Mr. Birkett remarks : "Contusions of an apparently trifling nature, at first slight, may yet be attended with appalling results. Thus, a delicate, strumous, badly-nourished individual receives an injury of the pelvic region, the primary effects being merely a local tenderness or stiffness. But in a few days intense constitutional disturbance may arise, and death ensue from disease of the membranes of the spinal cord."

Contusions may be of a severe nature, as from a spent cannon-shot or fragment of shell, producing great extravasation of blood under the integuments or gluteal fascia, giving rise to a circumscribed swelling, which may be recognised from that of an abscess by its appearing immediately after receipt of injury, whereas an abscess would be longer delayed. These swellings will, as a rule, disappear after repose and local application of stimulating lotions.

The soft parts covering the pelvis are frequently torn and lacerated by fragments of shell, splinters of wood, and other missiles. The wound should be readjusted, as far as possible, with a hope of their uniting.

Fractures, Dislocations, and Gun-shot Injuries.—The pelvic bones may be fractured, dislocated, and crushed ; or bullets, fragments of shells, &c., may be lodged in them. Such injuries are attended with risk to life, not alone from the damage to the bones, but from the contents of the region being involved in the mischief. In the treatment of fractures, most perfect rest should be enforced, the bones being first replaced, if possible. Dislocations should be reduced, and to assist the surgeon in doing so, "it is recommended to introduce the index finger into the rectum, while the patient is under the influence of chloroform, when the bones may possibly be brought into their normal relations with the sacrum."

In shot fractures there may be contusion, grooving of a single lamina, cleanly cut perforations, sinuous canals through the cancellated structure, comminutions with widely radiating fissures, detachment of fragments, or impaction in the spongy tissue. Much of the gravity in shot perforations of the pelvis will depend (as in chest perforations) as to whether the missile fractures the bone on entering, and driving the splinters inwardly, traverses the bony basin, or fractures it when emerging.

When the pelvis has been struck by a large shot, unless very obliquely, the destruction is so frightful that death ensues before inflammation has time to set in. Dr. Stromeyer has pointed out two important facts in relation to these injuries, which were corroborated during the American War of the Rebellion—viz., the liability to pyæmia and to greater danger where the missiles entered posteriorly and traversed the thick gluteal muscles, before fracturing the bone, the long shot tracks favouring purulent infiltration and sloughing.

Lodgment of Missiles in the Pelvis.—Mr. Guthrie has removed balls on different occasions which have lodged in the bones of the pelvis, and always with the greatest advantage when done early. He has seen much evil result from their being allowed to remain, as they caused not only frequent distress, but at last gave rise to disease in the bone, derangement of the general health, and death. "When the ball can be felt impacted in the bone, incisions through muscular parts of little consequence should not be spared to expose it. If an error exists at this moment, it is that too little is done rather than too much."

Mr. Hamilton, of the U.S.A., remarks:—"If a ball has penetrated either of the alæ, where they are thickly covered by the great gluteal muscles, it would be difficult to discover or to remove the fragments. The great depth of the muscular coverings, and the size and number of the blood-vessels with which they are supplied, render all surgical interference improper. But in case the perforation occurs near the upper margin of the pelvic bones, there can be no impropriety in instituting a search for any foreign substance which may be supposed to have lodged within. If the edge of the crest only is broken off, the finger can be easily carried along the track of the wound to a certain extent, and the probe may be introduced pretty freely without much danger of its doing harm. Indeed, it is our opinion that, in case the perforation was very near the crest of the ilium, constituting only a smooth round hole, through which the loose fragments could be distinctly felt, but was insufficient for their extraction, it would be proper to apply the trephine, so as to enlarge the opening. Certainly there is no more important indication than to remove the fragments, and we do not see why the surgeon, under these circumstances, need hesitate to perform so trivial and safe an operation at once. For this purpose a large trephine should be employed, and in order to avoid the necessity of dissecting up the muscles extensively for the purpose of finding a sound piece of bone upon which to rest the pin of his trephine, he might adopt the excellent suggestion of Mr. Guthrie in certain cases of fracture of the skull—namely, to support the crown of the instrument in a circular opening made in a bar of iron, the two ends of the bar being held and steadied by assistants; or perhaps it would answer equally well to employ for this purpose a piece of wood, the opening in which may have been previously made by the trephine itself."

Baudens recommends that when a missile perforates the ilium and lodges under or in the iliacus or psoas muscle, it is safer to seek it through an incision similar to that made for ligation of the common iliac artery, rather than to enlarge the shot canal in the bone.

Necrosis and caries frequently follow shot injuries of the pelvis, the patients leading miserable lives from the recurrence of suppuration and its consequences.

WOUNDS OF ORGANS OF MICTURITION.

Wounds of the bladder may be caused by concussion, without fracture of the pelvis, by the wheel of a gun-carriage passing over, by a fall, or by a heavy weight giving rise to rupture; with fracture of the pelvis, by splinters of bone, by bullets, or other missiles, bayonet, lance, or sword thrusts, a large vessel may be wounded, which may prove rapidly fatal from hæmorrhage.

All wounds of the bladder are extremely dangerous, but those produced by shot are less so than others, due, it is suggested, to the tissues being crushed by the projectiles, that eschars are produced, and the connective tissue protected from urinary infiltration.

Should the bladder be wounded, the sufferer may be so fortunate as not to be hit in a place where immediate extravasation of urine takes place, and consequently he may survive the wound, but will be subject to great suffering from inflammatory symptoms consequent on the injury producing irritability of the bladder and tenesmus. "The first measures, therefore, to be adopted, are to introduce a large elastic catheter and fix it in the bladder, so as to admit of the urine passing through it, as soon as formed, and prevent irritation by lodgment. Some patients will not tolerate its being fixed in the bladder; it must then be introduced frequently."

In the event of the bladder being injured so as to admit of extravasation into the pelvic cavity, or peritoneal cavity, the case will probably terminate fatally, from the amount of irritation and inflammatory action, or from the shock to the system.

I have already mentioned that in these injuries an attempt should be made to prevent further extravasation by the introduction of an elastic catheter; as, however, it is often a considerable time before the wounded come under the care of the surgeon, the mischief from extravasation may have taken place; but this should not prevent an attempt being made. In cases where the back part of the urethra or neck of the bladder has been injured, so as to prevent the introduction of a catheter, an opening should be made in the perineum to admit of the discharge of urine.

Should there be signs of external extravasation of urine, free incisions must be made in the perineum, or in such positions as will readily admit of its escape.

The early constitutional treatment in all wounds of the bladder should be that commonly adopted in acute peritonitis, which must inevitably set in. The bowels will require evacuation by means of oil enemata, but opium must form the great means of affording relief, and it may be administered by the mouth, by hypodermic injection, by a suppository, or by enema. The bladder should be kept in a state of complete contraction and repose, which is one of the most essential steps towards the healing of the wounds in its walls. Drinks should therefore be in small quantities. The diet should be very sparing at first.

Protrusion of the Bladder.—The bladder may be protruded in consequence of a wound in the abdomen, when it should be returned. This operation is facilitated by a gum-elastic catheter being introduced and the urine drawn off.

Bullets or other Foreign Bodies in the Bladder.—Shot wounds of the bladder are not uncommonly complicated by the presence of foreign bodies in the cavity of the organ, such as bullets, pieces of bone, clothing, hair. These may become encrusted with urinary deposits, and after a time require removal by the operation of lithotomy. In the Reports of the American War of the Rebellion, twenty-one cases, with three deaths, are given of the lithotomy for extraction of projectiles or traumatic vesical calculi.

Puncture of the Bladder.—The surgeon is sometimes called upon to perform this operation for retention of urine consequent on injuries of the urethra. Mr. Cock's method, per rectum, is the most simple, and is as follows:—"The patient is to be placed and held in the position for lithotomy, and brought well to the edge of the bed. The operator is then to introduce the index finger of the left hand into the rectum with the palm upwards, and to feel for the prostate, and, if possible, for the bulging base of the tense bladder beyond it, some little pressure above the pubes may help in this attempt. The pulpy point of the index finger is then to be held in the median line, just below the spot at which the puncture is to be made. The surgeon, with his right hand, is then to take from his assistant the canula, well oiled, and fitted with the blunt pilot trochar, and introduce it into the rectum, upon his left index finger, passing it well up to the point selected for puncture. He is then to steady the canula and hold it firmly in position with the thumb and three outer fingers of the left hand, and withdraw the blunt trochar. The sharp trochar is then to be introduced through the canula, and having reached its end, the handle with the canula is to be depressed and then driven home in a direction upwards and forwards, in a line towards the umbilicus. The trochar should then be withdrawn, and the canula pressed well home and secured. A plug may be placed in the canula to retain the urine."

The operation of lithotomy may be required in war time for the removal of bullets or other missiles from the bladder. The operation (lateral) is thus described by Sir W. Fergusson: "The point of the blade of the scalpel should be entered about 1¾ inch in front of the anus, about a line's breadth to the left of the raphe, pushed through the skin, and carried by a kind of sawing motion down the left side of the perineum, about 1¼ inch beyond the anus, the middle of the incision being at equal distances from the latter part and tuberosity. Next, the blade should run along the surface of the exposed fat and cellular tissue, and then the point of the forefinger of the left hand should be thrust into the wound a little in front of the anus, so as to penetrate between the accelerator urinæ and the erector penis muscles—the knife being applied to any part which offers resistance; when, with a little force to separate the tissues, the tip of the finger can be placed upon the membranous portion of the urethra, and the groove in the staff may be distinctly felt. The point of the blade, with the flat surfaces nearly horizontal, should now be carried along above the finger, made to perforate the urethra about three lines in front of the prostate, and then be slid along the groove until it has entered the bladder, having slit open the side of the urethra, and notched the margin of the prostate in its course. The forefinger of the left hand should next be slipped slowly into the bladder along the staff, in such a manner as to cause dilatation of the surrounding textures, and its point should be moved about in search of the stone, which, being found, should be retained in position near the neck of the viscus; then the staff should be removed, and the forceps introduced along the upper surface of the finger, slowly withdrawing the latter as the former makes progress: this will be denoted by a gush of urine, at which instant the blades should be separated, when, on gently approximating them, the stone will in all probability be felt enclosed."

WOUNDS OF THE ORGANS OF GENERATION.

Wounds of the Penis, Perineum, and Urethra.—Missiles have been known to traverse the penis and perineum, and otherwise injure these parts. In wounds where the urethra has been laid bare, a catheter should be introduced and tied in; and, if the wound be clean, with edges in such condition that adhesion might be anticipated, they should be brought together by interrupted sutures; but, if much lacerated, it will be necessary to wait patiently the process of healing by granulation, taking care that the urethra is kept free by the introduction of a catheter whenever the patient requires to pass water. When the laceration has been so extensive that closing by granulation is impossible, it is best to try and retain the direction and patency of the urethra as far as practicable by frequently introducing a sound or catheter, and afterwards closing the wound by a plastic operation.

Erections are a great hindrance to the healing of wounds of the penis, they tend to induce hæmorrhage and necessarily break up incipient adhesions, retarding union. The parts should be lightly dressed, the bed should be hard, regimen spare, and excitement avoided. Camphor and hyoscyamus may be given with advantage.

Retention of urine is not uncommon with laceration of the urethra; an attempt should first be made to pass a catheter, which should be done with the greatest gentleness. If this is impossible from the torn condition of the urethra, the bladder should be punctured. On the first appearance of infiltration deep and free incisions are necessary.

Foreign Bodies in the Urethra.—The urethra may be obstructed by foreign bodies being driven into the canal by projectiles, or expelled from the bladder, such as fragments of bone, clothing, and small projectiles. When situated near the meatus, it is possible to remove them with a small forceps, a bent probe, or metallic loop; but should such simple means be unavailing, it will be necessary to resort to incision, which would be more prudent than incurring any danger to the canal by persistent efforts at extraction.

Wounds of the scrotum, when uncomplicated, are not very serious, and require but little interference; open wounds should be closed by sutures, and the parts dressed with cold water and well supported. It may be laid down as a general rule that all incised or lacerated wounds of the genitals should be closed by sutures, if the parts can be possibly brought together.

Balls may lodge in the scrotum without doing any injury to the testes or other parts, and should be removed.

Wounds of the testes cause intense pain, extending to the lumbar regions, attended by faintness, and often by vomiting and even collapse. They may be severely bruised, shattered, or detached from the cord. Of 586 cases of this group reported as having occurred during the American War, the largest proportion consisted of lacerated wounds of one or both testes.

Relief must be afforded by the administration of opium; the organ should be well supported, and cold or warm water applied. Should there be any portion of either testicle partially detached, or extensively lacerated, it may be removed, as in all probability it will become diseased. Guthrie removed the bruised and shattered remains of testes and epidydimis to expedite the cure.

Wounds of the spermatic cord are generally associated with wounds of the testes; they are of infrequent occurrence, and rarely lead to fatal consequences; it may, however, be necessary to ligature the spermatic artery in cases of violent hæmorrhage from it.

WOUNDS OF THE ORGANS OF DEFÆCATION.

Wounds of the Rectum and Anus.—Lacerated and incised wounds of these regions are rare in war, the parts being more or less protected, but shot wounds of the rectum are not infrequent.

During the Crimean War and Indian Mutiny, the writer* only saw one example of this description of wound, which occurred to a soldier who, while attending to the calls of nature in an advanced trench, and in the squatting position, was struck with a fragment of a shell, which removed the scrotum as if it had been done by a knife, lacerated the buttocks, and divided the sphincter ani, causing violent hæmorrhage and involuntary passing of stools. The misery and intense suffering of this patient can scarcely be described, and as the healing process was entirely by granulation, he was a long time under treatment.

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* Porter.

Incised wounds of the rectum and anus heal very readily, but from their close proximity to the bladder and peritoneum, inflammatory symptoms must be looked for and checked. The bowels should be kept in a state of perfect repose, and strict cleanliness of the parts observed.

Shot wounds of the rectum are generally complicated with fractures of the pelvic bones or injury of the bladder, and most commonly prove fatal from pelvic cellulitis, blood-poisoning from fæcal infiltration, diffuse suppuration, or secondary hæmorrhage. Should a patient with such a wound survive, he will in all probability suffer from a stercoral or urinary fistula, kept open by discharges from carious bone or the occasional escape of sequestra. These injuries may also give rise to paralysis with incontinence of fæces, obstinate constipation, stricture, muscular contraction, and recurrent abscesses.

Dupuytren recommended a division of the sphincter in cases where the fæces were retained and overflowed through the perforation in the upper part of the gut. This practice was adopted with most satisfactory results during the American War and the Franco-German War of 1870-71. Possibly forcible dilatation of the sphincter by means of both thumbs of the surgeon would suffice, as this paralyses the sphincter for a time; the dilatation should be slowly and steadily effected by working the thumbs in opposite directions until the anus is perfectly flaccid.

Hæmorrhage of the rectum should be promptly attended to; a bladder may be introduced and dilated with ice water directed from a tube attached to an inverted bottle or irrigator. In serious hæmorrhage the gut must be dilated by a speculum (fenestrated), and bleeding vessels secured if possible. It may, however, be necessary to apply the actual cautery, galvanic current, or perchloride of iron.

WOUNDS OF THE EXTREMITIES.

Classification of Wounds of the Extremities.—These wounds may be divided into contusions, lacerations, incisions, or punctures of soft parts, injuries of bones or joints, all of which may be complicated with wounds of the great arteries or nerves.

With regard to contusions, lacerations, incisions, or punctures, their treatment has already been remarked upon; it is therefore unnecessary to refer to these again. Injuries of bones and joints will now be considered, and, in connection with them, wounds of arteries and nerves.

General Remarks on Gun-shot Fractures.—"Bones may be injured by having the periosteum contused or removed, as when a bullet is flattened against them, giving rise to periostitis, exfoliation, or throwing off of scales and frequently to disease of the medulla, or formation of deep abscesses, producing great constitutional disturbance."

Bones may be fractured—which injuries, as in civil life, are divided into simple, compound, and comminuted; but in consequence of the instruments or weapons which inflict them in war, they, as a rule, present peculiarities to the army surgeon not met with in civil life, where accidents to bones generally arise from falls, kicks, or muscular action, whereas in the army fractures are for the most part caused by direct violence, by spent cannon-shot, bullets, slugs, grape-shot, fragments of shell, and other missiles, causing many complications.

Simple fractures are probably the most rare of all kinds met with on active service; but should such occur in the field, the surgeon will have much to consider, as, from any want of care, or from improper adjustment of splints, the broken ends of the bones may protrude through the soft parts and form a compound fracture.

There may be great contusion of the soft parts, which will interfere with the adjustment of the splints, and add to the difficulties in transport. Numerous plans have been invented and proposed for the transport of fractured limbs, such as plaster of Paris bandages, wire-trough splints of the French, and various splints made from materials which may be found at the time of the injury, as already described under the head of "Extemporary Appliances" (page 2 *et seq.*)

Compound fractures are usually produced by the direct contact of a bullet or other missile with the bone, and consequently inflicting most serious injury to the bone itself and surrounding parts, but not necessarily producing a comminuted fracture, as might be expected.

Partial Fractures.—Sir T. Longmore describes partial fractures, which he says "can scarcely be produced by any other agents besides projectiles, and which are rare accidents in civil practice. They are:—1. Removal of portion of a bone by the projectile making a furrow in its passage across its surface—grooving it. 2. Removal, splintering off, of longitudinal fragments from the external cylindrical part of a bone. 3. Removal of a part of the bone by completely punching out a portion, thus leaving a hole through the entire substance of the bone. 4. Partial fracture, by driving inwards parts of the external cylinder, and causing the fragment to lodge in the cancellated structure. This latter partial fracture is generally attended with lodgment of the projectile also. Among the complete fractures, those attended with general comminution in the neighbourhood of the part of the bone struck, with dispersion of the fragments among the surrounding soft tissues, and those which may be spoken of as 'resecting fractures,' can hardly be caused accidentally, except by fire-arm projectiles." And lastly, "indirect fissured fractures," which he describes as a fissured or linear fracture occurring at some distance from the point of impact of the projectile, with an interval of sound bone between the seat of known fracture and the indirectly produced fissure. This distinct and separate fissure in the shaft of a long bone would account for inflammation, and persisted irritation being set up in a limb at a distance from the known seat of injury.

Considerations respecting the management of Simple and Compound Fractures in the Field.—In arranging for the management of fractures in the field, many difficulties have to be contended with: first, the transporting of patient from field to fixed hospitals, then the securing of proper beds, ventilation, and nursing. If an attempt is made to save a limb extensively fractured, the wound in the skin, if very small, should be closed by lint soaked in blood or tinct. benzoin comp., or carbolic or eucalyptus oil,* and every endeavour made to form a scab, whilst splints or plaster of Paris are so applied as to ensure absolute rest to the broken bones. But if the wound in the soft parts is large, or if it has been exposed for some time before coming under notice, the whole wound should be thoroughly washed out by a 1–20 carbolic solution, or by one of chloride of zinc, 40 grs. to the oz., or by tincture of iodine, 1 drachm to 10 oz. of water. The best way to do this is by a catheter and a syringe, the solution used should be made to go into all the interstices of the wound, but yet must not be forced into the connective tissue around the seat of injury—a thorough drainage must be established, then the wound should be dressed with a full gauze-dressing or by some of the absorbent and antiseptic wools or lints, as the salicylated, or mercurialised wool, iodoform gauze, &c.; but if these cannot be obtained, then the best dressing would be free and frequent irrigation with some antiseptic solution, and a covering of oil-silk immediately over the wound, protected by means of soft tenax, carbolised tow, or cotton wool. The greatest care should be taken to avoid all retention of discharge, counter-openings being made when necessary. Supposing the wound to keep aseptic, the blood clot in it should not be disturbed but be most carefully protected.

Mechanical appliances are now so perfected that, with the exception of some fractures of the femur, there is no lesion of the bones of the extremities that surgeons need have the slightest hesitation in transporting for considerable distances, prior to inflammatory symptoms setting in, care being observed as to the adaptation and application of splints.

Dr. Stromeyer remarks on this important subject: "Above all things it appears to me to be necessary, that cases of gun-shot fracture of the thigh should not be transported to a distance, but should be carried on a stretcher to the nearest house, and the treatment carried out there, even at the risk that the wounded should fall into captivity."

Gun-shot fractures of the upper extremities are less dangerous than in the lower, circumstances being as nearly as possible alike.

Gun-shot fractures of Humerus.—Guthrie remarks: "An upper extremity should not be amputated for almost any accident which can happen to it from musket-shot; and there is scarcely an injury of the soft parts likely to occur which would authorise amputation as a primary operation."

Sir T. Longmore considers that "unless the bone be extremely injured by a massive projectile, or longitudinal comminution exist to a great extent, especially if also involving a joint, or the state of the patient's health is very unfavourable, attempts should always be made to preserve the upper extremity after a gun-shot wound."

The experience of the American War gives authority for conservatism in dealing with shot fractures of the humerus, except in most aggravated cases. Drs. Warren and Chisholm in their manuals advise attempts to save the limb even when the fracture is complicated by division of the brachial artery, and M. Legouest considers that shot comminution of the humerus, even when complicated by wound of the brachial artery, does not render amputation "indispensable."

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* Vide Formulæ in Appendix.

A case is related of a soldier in India receiving a sword cut, which divided his arm, bone and all, with the exception of the vessels and nerves, and the muscles on the inner side, yet he recovered, the bone of the arm uniting.*

Mr. Guthrie recommends that when the splinters extend far into the shaft of the humerus, it may be proper to amputate the whole extremity, especially if the great artery and nerves be wounded; if, however, the head is not injured, the amputation should take place immediately below the tuberosity, and not at the joint, so as to retain the round appearance of the shoulder.

When the shaft of the humerus is much splintered, detached pieces should be removed, fragments of clothing or foreign bodies extracted, points of sharp splinters should be cut off, and the arm placed on a convenient splint, pillow, or cushion, giving it perfect support and rest. For this purpose Dr. Stromeyer has designed a cushion, the utility of which he was so good as to demonstrate to me † at Versailles, during the late Franco-German War. An illustration can scarcely do credit to this admirable contrivance, which affords perfect security and comfort to the injured limb, and with which every army hospital should be supplied.

"The cushion may be described as a right-angled isosceles triangle, 4 inches thick at the apex, which rests against the chest and supports the elbow, the forearm being bent at a right angle with the arm. The cushion gradually thins down till the base is a mere edge, and of the two other angles, one is passed up into the axilla, while the other rests on the chest under the wrist, as represented in fig. 81. The cushion is readily fastened in its place by a tape round the neck, and one round the body, as seen in fig. 82. When this simple apparatus is applied, the arm rests

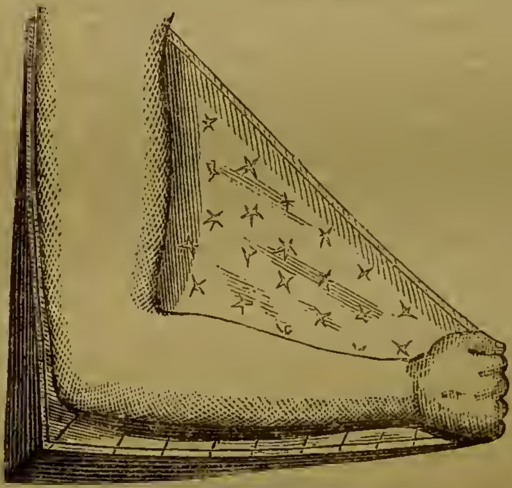

Fig. 81.

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* Macleod's *Notes on the Surgery of the Crimean War*, p. 304. † Porter.

upon it, beautifully supported, and in excellent position. Whilst lying in bed, nothing beyond the ordinary dressings are required for the wound, and if the patient needs to be transported from one place to another, or is fit to walk about, this can be arranged for with the utmost facility, as cushion, arm, and all can be bound by a broad bandage to the body, and thus form an immovable whole."* Stromeyer informed Sir W. MacCormac that so highly did he estimate the value of this cushion, as to consider it the most valuable appliance he had invented during his life. Sir W. MacCormac has tried the mode of treatment and found it answer every purpose, and recommends a good-sized cushion, of which the sides measure about 14 or 15 inches in length. I† have used this appliance myself, and cannot speak too highly of it, but it requires different measurements for different persons.

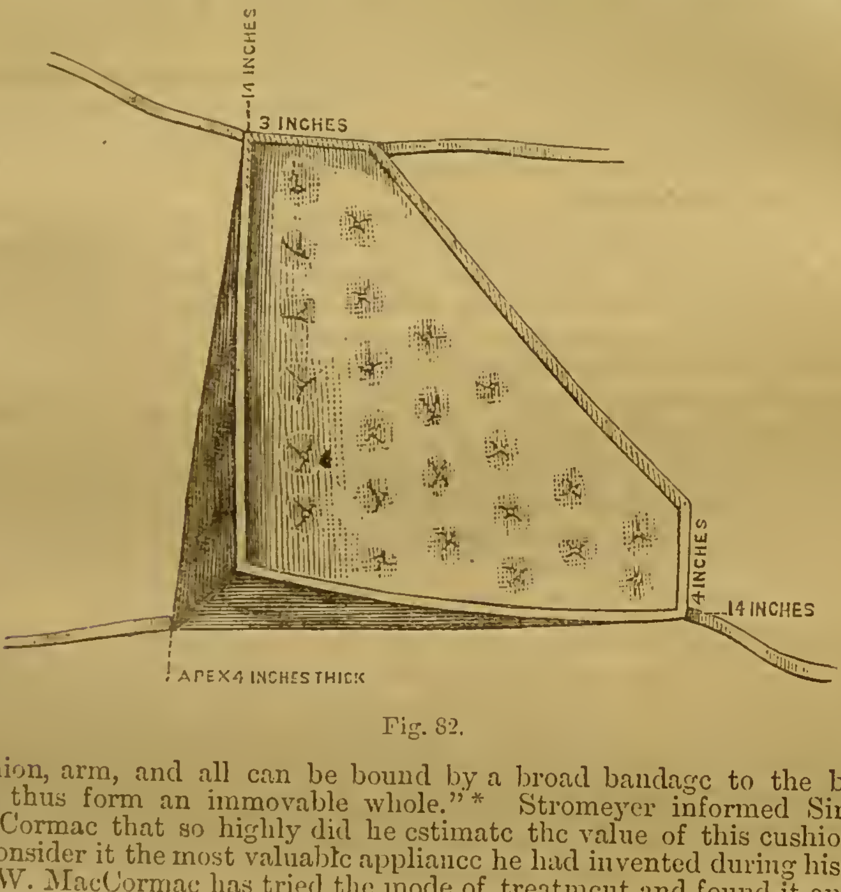

Fig. 82.

Hamilton, of the United States Army, in the treatment of gun-shot injuries of the humerus, usually employs a single splint made of felt, leather, or gutta-percha, long enough to extend over the top of the shoulder on the one hand, and to the lower part of the elbow on the other, and broad enough to encircle one-third of the circumference of the arm. By moulding, or otherwise fitting the upper part of the splint over the top of the shoulder, it will be prevented from becoming displaced downwards. He considers that bandages have, as a rule, been applied too tightly.

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* *Notes and Recollections of an Ambulance Surgeon*, by W. MacCormac, p. 96.

† S.-M. Porter.

Injury of the head of humerus (*vide* "Injury of Joints").

Shot Fractures of the Clavicle.—As in fractures of the long bones, detached splinters should be immediately extracted. Extirpation of the clavicle for shot injury is seldom, if ever, called for.

Shot Fractures of the Scapula.—Bleeding should be arrested. Foreign bodies or detached structures should be removed, and the parts kept at rest by supporting the arm. Burrowing of pus in the dorsal and lumbar regions is a very common complication in these injuries, from the extension of septic inflammation.

Shot Fractures of the Radius and Ulna.—The radius or ulna may receive extensive injuries from bullets or fragments of shells, the rule of treatment for such injuries being to remove fragments of bones or splinters, and place the arm on a suitable splint with a view to union taking place; at the same time, passive motion should be adopted early to prevent the bones uniting with one another, thereby rendering pronation and supination imperfect. When both bones are extensively broken, the soft parts lacerated, and vessels and nerves damaged, which often occurs from a bullet passing through both bones across the arm, amputation should be performed, but every endeavour should be made to save a forearm which is well supplied with blood; mortification is consequently not likely to take place.

In the event of amputation being necessary, the surgeon should be careful to leave as long a stump as possible, to which a mechanical contrivance can be attached.

Hamilton suggests that in case both bones are broken, the patient ought to be kept in the recumbent position on the back, with the forearm resting upon a pillow supported by a board, extended and supinated. No attempt should be made to lengthen the limb by apparatus, but daily attention should be given to the position of the bones, and, as far as possible, they should be kept in line.

Shot Wounds of the Hand.—In wounds of the hand, as little as possible of the injured parts should be removed, and, above all, the value of the thumb or a finger should be carefully considered in any operative measures.

In extensive wounds from cannon-shot, or fragments of shell, amputation of the hand may be necessary; but wounds from bullets generally damage one or two metacarpal bones, or may pass between two, only injuring the soft parts.

There may be very troublesome hæmorrhage from wounds of the palm of the hand; this is best arrested by freely exposing the bleeding vessel, by enlarging the wound, and boldly clearing away all coagula, and applying a graduated compress, this should be regularly and methodically done, and the hand well raised, but should this fail by the hand swelling and threatening to become gangrenous, the radial and ulnar arteries will have to be tied above the wrist.

Shot Wounds of the Metacarpal Bones.—When the metacarpal bones are injured, that is, splintered, the wound should be enlarged and the fragments removed, taking care that the tendons are not injured or interfered with, if untouched by the missile. Generally speaking, the extensor and flexor tendons are injured, the result being stiffness of the fingers to which they belong. Guthrie recommends that, when one or more fingers are destroyed, and the metacarpal bones injured, they are to be sawn or cut off, but not removed at the carpus, although an opening into the joint of the carpus will generally do well, if skin can be saved to cover it.

In all cases of amputation of one or more fingers, the metacarpal bones, if injured, should be left as long as possible, and particularly that of the index fingers when the thumb remains.

Shot Wounds of the Fingers.—The phalanges may be broken, when, if in a single finger, a splint composed of wood, gutta-percha, or other suitable material, should be placed on the palmar surface of the entire length of the finger, a piece of lint, cotton wool, or other soft texture being first laid against the skin.

If several fingers are broken, the splint should cover the whole palmar surface, the wrist joint being left free.

Incised Wounds of the Forearm and Wrist.—The hand, wrist, and forearm are liable to sword-cuts, which frequently injure the bones or joints. It is seldom necessary to do more than close the wounds, and support the parts by suitable splints, after all divided tendons have been accurately approximated by catgut sutures.

Gun-shot fractures of the lower extremities are far more dangerous and serious than those of the upper; and as to fracture of the femur, either simple or compound, it will, on active service in the field, cause the surgeon grave anxiety, and perplex him as to the best measures he can adopt, for opinions vary much on this subject.

Shot Fractures of the Femur.—An important question for the consideration of the army surgeon is—What is best to be done for severe gun-shot fracture of the thigh with an army on the move, as transporting a sufferer with such an injury is a very serious matter? Stromeyer is of opinion that it is best to leave the sufferer in captivity. Esmarch is, doubtless, of the same opinion, as, during the Holstein War, he entrusted such wounded to the enemy, rather than allow them to suffer from transport. There are, unfortunately, occasions where it is not possible to carry out this excellent advice of Dr. Stromeyer, which in European warfare, and under the privileges of the Geneva Convention, should be adhered to. But supposing the contest is with savage tribes, as has lately occurred with the British forces in the Soudan, that the distance is considerable to a permanent hospital, that the roads are bad, and transport indifferent, what, then, should be the course of action?

During the Ashantee expedition, 1874, a soldier of the 42nd Highlanders experienced a simple shot fracture of the right femur at Amoaful, and by means of a long side splint was safely carried to the port of embarkation; and during the Perak expedition, 1875, two soldiers of the 10th Regiment had the lower third of the right femur fractured, but without comminution. Both were safely transported with the aid of ordinary splints.

But a patient suffering from a severe gun-shot fracture of the middle or lower third of the thigh could scarcely be carried a considerable distance over bad roads (such as occurred in Western Africa) without further endangering his life. I* am, therefore, of opinion that the chances of preserving life would be increased by immediate amputation, there being no doubt that, to secure success for conservative ~~treatment,~~ the sufferer must not have undergone lengthened transport, fatigue, or privation.

An amputation of the thigh having been performed, the stump can be easily secured for the safe transport of the patient.

In gun-shot fractures of the upper third of the femur under the foregoing circumstances, the surgeon should try and conserve the limb on account of the great mortality attending amputation in this region.

Surgeon-General Longmore says—"The results so far accumulated while indicating the propriety of practising conservatism in gun-shot fractures of the upper third, on the other hand, inculcate amputation to be the safest practice in gun-shot fractures of the middle and lower third of the femur." Such is the general opinion, but it may subsequently be modified as it is shown by Surgeon-General Longmore, "that the modern rifle bullet makes small holes, is apt to split bones without always tearing the periosteum completely, and this, together with improved methods of treating the flesh wounds, may render it possible to save limbs that would otherwise have to be lost." But the question, how far it is possible to ensure rest will always form a leading feature in determining what course to pursue with shot-fractures of the femur in the middle and lower third. In these, as in fractures of the head and neck of the bone, it is the life of the patient that is at stake, and not whether it is possible to avoid a mutilation. Therefore, with a compound fracture of the femur in the middle or lower third, and with the certainty of continual unavoidable moves, experience says that amputation is the man's only chance of life.

Guthrie, referring to the result of treatment of forty-three selected fractures of the thigh, which were attempted to be saved under his own direction at the battle of Toulouse, reports that of this number thirteen died; twelve were amputated at the secondary period, of whom seven died; and eighteen retained their limbs. But he considers the result most unsatisfactory, notwithstanding the care and attention bestowed upon them.

"Nearly all the wounded, after this battle, had every possible assistance and comfort from the second day after the action. The hospitals were well supplied with bedsteads—no inconsiderable point in the treatment of fractures. Every broken thigh or leg was in the straight position, and the success was greater than on any previous occasion. Nevertheless, with all these advantages, there can be little doubt that, if amputation had been performed in the first instance on the thirty-six out of forty-three who died or partially recovered, some twenty would have survived, able, for the most part, to support themselves with a moderate pension, instead of there being perhaps five, or at most ten, nearly unable to do anything for themselves." The least dangerous and most likely to be saved, he considers, are fractures of the lower third, or at most of the lower half, of the thigh bone; and when they do not communicate with the knee-joint, an attempt ought always to be made to save the limb.

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* S.-M. Porter.

Mr. Alcock remarks on this subject: "I do not agree with Mr. Guthrie;" and though he admits his experience is more limited, still he is of opinion that the expediency on service of ever delaying the removal of the limb with a complete fracture of the femur lower third from gun-shot wound appears to him doubtful. This only refers to soldiers; with officers the results are less unfavourable.

During the Crimean War, the treatment of this injury afforded a subject of great interest. Sir T. Longmore informs us that the practice of conservative measures, as a means of preventing amputation, was not encouraging. Of the three modes of treatment, resection was the most fatal, conservative treatment next, and amputation least fatal. The first was uniformly fatal; the deaths among cases treated without operation were 82 per cent.; the deaths among those treated by amputation, almost hopeless cases included, were 65·2 per cent.

In the official history of the Crimean campaign, the recoveries after amputation in the upper third were 12·9, in the middle third 40, in the lower third 43·3 per cent. of the cases treated; but the distinction is not made in regard to the recoveries without amputation.

Stromeyer, who has had great experience, has favoured us with the following opinion:—"I differed from Guthrie in one essential point—that of his preferring amputation for gun-shot fractures of the thigh to conservative treatment. Guthrie puts too much stress upon the imperfections of conservative treatment, the result of which is often a very disabled limb, whose possession does not make the patient very comfortable. But these imperfections admit of improvement, while a *high amputation gives no prospect of better chances;* it will always remain a very dangerous operation. Our first object is to save a man's life, and the second to make him comfortable, but not in his grave. My results of conservative treatment in gun-shot fractured thigh during the first three campaigns of 1849, 1850, and 1866, did not go beyond 50 per cent. healed. I saw the reasons of our failures, tried to avoid them, and went on with conservative treatment. In the two campaigns in Schleswig-Holstein (1849 and 1850), the patients had to be carried to considerable distances. After the battle of Lanzensolza, in 1866, I was unable to prevent many cases from being spoiled by an injudicious use of plaster bandage. It was in Floing, near Sedan, where we succeeded in saving 77 per cent., twenty-seven amongst thirty-five patients, who had been carried to no great distance, and were treated without putting much restraint on their shattered limbs."

"According to my opinion, the great principles to be followed in compound fractures in general are:—(1) Dressing the wounds without lifting the limb; (2) avoiding constriction; and (3) not irritating the muscles in straining them by mechanical contrivances. A gun-shot fractured thigh permits a weight to be suspended to it, keeping the limb a little at rest, like the hand of an assistant, but not an extension by weight or other contrivance which gives the limb its proper length, except in very few cases."

"The most common case is, that for some time after the accident the muscles retain a tendency to retract which is increased by opposition, and ceases by-and-by in a favourable position of the broken limb."

It appears remarkable that such eminent authorities as Stromeyer and Guthrie should differ on this point; but the fact is, that Guthrie formed his opinion from experiences in the Peninsular and Crimean campaigns, where fractures of the femur were treated under circumstances totally different from the experiences of Stromeyer, who in all probability was enabled to secure proper accommodation, food, and attendance for his wounded; whereas, during the Peninsular and Crimean Wars every discomfort and inconvenience that man could be subjected to were present with the British army, which unfortunate circumstance gave conservative treatment the disadvantage.

Pirogoff, in 1849, after great mortality from thigh amputation for gun-shot fractures, was induced to try conservative treatment in ten cases of bad compound fracture of the thigh, which did well, not only without operation, but without treatment of any kind. He was also of opinion that the application of a permanent paste bandage would render the transport of such wounded possible. During the Crimean War he experienced 90 to 95 per cent. death-rate in primary thigh amputations, as did the French; but in the German hospitals, during the war of 1870-1871, more than thirty cases of recovery from gun-shot fractures of the upper and middle thigh were met with; whereas, of thigh amputation only twenty-one survivors were found, and in none of these had the operation been performed in the upper third.

During the early part of the siege of Sevastopol when the wounded were subjected to every discomfort that can possibly be imagined,—when the best bed was a bundle of brushwood, without blankets, in a bell tent on a mud floor, the prospects of treating a compound fracture of the femur conservatively were most unfavourable, and that of amputation little better; but of the two, amputation in the middle or lower third gave the sufferer the best chance. Again, take exposure in a tropical climate, with intense heat, indifferent accommodation, and want of competent nursing, amputation would no doubt be attended with more favourable results. It is, therefore, only under certain conditions, such as good accommodation, food, ventilation, and attendance, with suitable appliances, that conservative treatment should be attempted.

Dr. G. H. B. Macleod (who closely observed these injuries in the Crimea), remarks: "It can hardly be doubted that the great straining after conservatism which influenced all the surgeons of the army was one main cause of the mortality which attended these injuries." Again he says that, "under circumstances of war similar to those which occurred in the East, we ought to try and save compound comminuted fractures of the thigh when situated in the upper third, but that immediate amputation should be had recourse to in cases of like accident occurring in the middle or lower third."

Erichsen considers (though doubtless there are exceptions to this, as to all general rules in surgery), that all compound fractures of the lower third of the femur occasioned by gun-shot require amputation.

Mr. Hamilton of the U.S. Army, in his remarks on gun-shot fractures of the thigh, says: "We have not in our possession full statistics of the present war, but sufficient facts have come to our knowledge to indicate that there has been, on the part of our surgeons, a large amount of conservatism, especially in reference to the treatment of gun-shot injuries to the thigh. Our own impression is, that in those injuries conservatism has ruled too much, and that amputations have been too little practised."

To guide the surgeon as to when he ought not to attempt to save the limb, but proceed to amputation at the thigh after a gun-shot fracture, he lays down certain rules which are as follows:—

"When a patient has to be carried far over rough roads, and without adequate support to the limbs.

"When the bones are greatly comminuted.

"When the patient suffers great pain, or violent spasms continue in spite of opiates and rest.

"When the soft parts have suffered great contusion, as in the case of a fracture from solid shot or shell.

"When there is very extensive laceration of the soft parts.

"When the principal arteries or nerves are involved in the injuries.

"When the fracture implicates the knee-joint, or even when it is near the knee-joint.

"Under the following circumstances we would not, as a rule, resort to amputation:—

"When the ball has entered the head, neck, or trochanteric portion of the femur; if any surgical operation is demanded in these cases, it is usually ex-section.

"When the fracture is just below the trochanters; experience having shown that very few recover after these amputations.

"When the fracture of the femur is caused by a pistol-ball, by a round musket-ball, or by any missile whose force is nearly spent.

"It will be understood that the last observation has reference solely to the less degree of comminution which these missiles usually occasion.

"The following conditions must be added as essential to the success of conservative measures:—

"All pieces of bone which are only slightly attached to the soft parts must be removed.

"All foreign bodies, such as fragments of balls or other missiles, pieces of cloth, wadding, &c., must be carefully taken away. Whatever binds or obstructs the external opening, and prevents the free escape of blood or of pus, must be divided or removed.

"The limb must be placed in a position of absolute rest, and must remain at rest. It must not be confined by tight bandages, or forcibly extended by apparatus.

"If the knee-joint be implicated, it must be laid freely open and placed at perfect rest, without adhesive straps, bandages, or other means of compression.

"During the whole treatment, the limb must be handled with great care, and not lifted roughly or carelessly. When sinuses form, the matter must be let out by direct or counter-openings, and not by violent pushing and thumbing.

"When spicula of bone present themselves they must be removed.

"The patient must be supplied with good nourishing diet."

Examination of Wound.—The condition of a fractured femur from a rifle-bullet is always a matter of great obscurity, and it is therefore impossible to decide what steps should be adopted without making a most careful examination with a view to ascertaining the extent of injury.

Stromeyer says that probing should never be done in cases of fractures of the shafts of bones which are intended to be treated conservatively; and that in operation cases, the examination should be made immediately prior to the operation.

Long and deep incisions may have to be made, and the extent and number of them will depend upon the size and number of the splinters. It has been recommended that the wound of exit is the proper place to look for sequestra, as the ball, in passing through or traversing a limb, naturally carries them with it.

The depth of splinters in muscles is not to prevent incisions being made, nor should their proximity to large vessels or nerves interfere with a diligent search after them. It is of the most vital importance that they, as well as articles of clothing, the bullet itself, or other foreign bodies, should be removed, and with the least possible delay.

The limb will soon swell, and become very painful, and the longer the operation is postponed the more painful is the case to the unfortunate patient, the more difficult to the surgeon, and the prospect of saving the limb more unfavourable.

Much care will be required in removing small fragments in the after-treatment, and giving free vent to pus both in the neighbourhood of the wound and along the axis of the bone when abscesses form in connection with unobserved splinters.

Sequestra and the Classification of them.—Dupuytren has divided sequestra into three classes—viz., Primary, Secondary, and Tertiary. The primary are those wholly separated; the secondary those partially adherent, probably by a slight piece of tissue; and the tertiary those which become necrosed. There are generally longitudinal sections into which the bone is split, which are sometimes capable of consolidation. The wholly separated portions should be at once removed, as, if not, they soon set up irritation, abscesses, pyæmia, and the usual terrible results.

Some doubts have existed as to the advisability of removing those under the class secondary, or those partially adherent, from the supposed possibility of consolidation taking place; but it is now generally admitted that, in doubtful cases, or in those where the adherence of the sequestra is but slight, it is best to remove it; the chances are so much in favour of its becoming wholly detached, acting as a foreign body, with its painful consequences, that the disadvantages of such a contingent are in no way counterbalanced by the fortunate circumstance of consolidation, which is remote. Guthrie, Roux, Baudens, Legouest, and Begin are in favour of their removal.

Extension in Treatment of Gun-shot Fractures of the Femur.—In treating gun-shot fractures of the thigh-bone by conservative surgery, most competent authorities agree that it is best to keep up extension to a moderate degree, but, in the event of a portion of the bone being removed, there will be a space between the broken ends; if, therefore, strong extension is made, the ends of the bone will be drawn asunder, and continued irritation of the muscles and surrounding tissues will be kept up.

To prevent shortening is almost an impossibility; it will, therefore, be best to allow the ends of the bone to approximate, which the muscles will do of themselves, and all that can be done is to keep the limb straight, if possible. The less interference the better.

Stromeyer observes: "Do not be too anxious to remove all the fragments of fractured and displaced bones. Do not be too eager to maintain extension of the fractured limb, and abstain from frequently lifting the fractured limb for the purpose of cleanliness."

Contrivances for the Treatment of Shot Fractures of the Femur and Bones of the Leg and Foot—(1.) *The Femur.—While simple fractures of the shaft* may be put up in the semi-flexed position of Pott, the straight one of Desault and Liston, or on the double-inclined plane, or by any of the numerous modifications of either, it is otherwise with the *compound fractures* resulting from gun-shot. Hence, numerous contrivances and apparatus have been invented for the more convenient treatment of shot fractures of the thigh-bone; in fact, any one who has ever had to treat such an injury on service can bear testimony to the difficulties and dangers to be encountered.

Mr. Hamilton does not recommend "the long straight splint, with the usual means of extension and counter-extension, in any of its various forms, unless in rare cases. A perineal band can rarely be borne in gun-shot fractures of the thigh, and a long, broad side-splint is always very much in the way of dressings." The method he recommends is, "laying the limb upon the mattress or some sufficiently firm and even support, or on the same or nearly the same plane with the body, making the extension by a weight attached to a cord drawn over a pulley, while the counter-extension is made with the weight of the body, by elevating the foot of the bed. This is the plan, more or less modified, which has been adopted in a large proportion of the cases which we have seen under treatment; and, we think, with the best results.

"With the straight position, the limb may rest directly upon the bed, when it is not always accessible for the purpose of dressing the wounds. The limb may be moderately lifted or suspended by a frame and cotton bands.

"When extension is applied, it should be moderate and barely sufficient to steady the limb, or to prevent the ends of the broken bones from pressing into the flesh. For this purpose we apply a broad band of adhesive plaster along each side of the leg, from the knee downwards, and secure these in place with a roller, covering certain portions of the limb with cotton wool before applying the roller, to prevent excoriation. The end of the adhesive plaster should be laid over a small block below the sole of the foot, which block must be of sufficient width to protect the malleoli from the pressure of the bands. A small rope, knotted at one end, is then to be run through a hole in the centre of the block, and carried over a pulley at the foot of the bed. The pulley must be so high that the extension shall lift the heel a very little from the bed."

Mr. J. T. Hodgen has invented an apparatus by means of which the limb is maintained in a straight position, while at the same time it is lifted from the bed and rendered more accessible (fig. 83). "The apparatus is composed of four nearly parallel bars and a foot-board; two of the bars constituting the base, and the remaining two, covered by transverse slips of cloth, being intended to receive and support the limb.

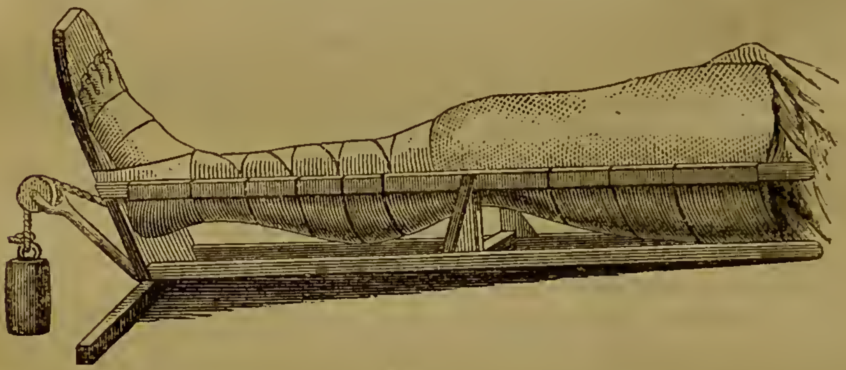

Fig. 83.

"The longitudinal bars are 42 inches long, and the upper bars are elevated 4½ inches above the lower; the space between them diminishing from the upper to the lower ends, being 12 inches at the groin, 8 at the knee, and 4 at the foot. The foot-board is 14 inches high, 4½ inches wide, and is supported by a cross-piece or foot underneath, 15 inches long.

"The transverse strips of cloth, each 2½ inches wide, are placed in contact, and adapted to the inequalities of the limb.

"Adhesive straps are secured to the sides of the leg by a roller, and brought around the foot-piece; a cord, to which is suspended a weight, is made fast to the centre of the foot-piece and passed over a pulley, and this constitutes the extension. The counter-extension is made by lifting the foot of the bed 4 or 6 inches."

Mr. Hodgen has also invented a splint whereby the limb can be suspended, which it appears he has substituted for his own "cradle." "It is made of iron wire (size No. 2), and resembles in many points Dr. Smith's anterior splint, but its mode of application is not the same. Strips of cloth are laid across the splint from side to side, and upon these the limb is laid. The centre and upper extremity of the splint are kept asunder by strong bows of iron wire, so arranged that they can be put on or taken off without disturbing the dressings. When applied, the inside wire must be bent upwards at its upper extremity, so as to make room for the pubes. Extension is made by adhesive plaster, and the whole apparatus is finally suspended to the ceiling, or to some point above, by a rope and pulley" (fig. 84).

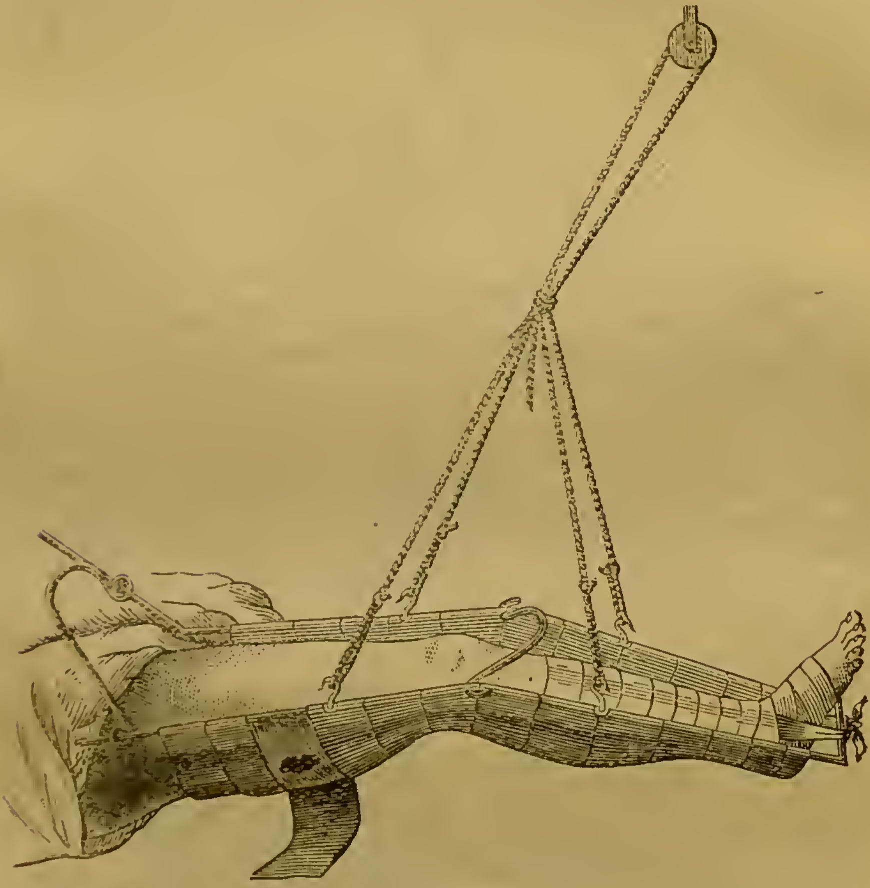

Fig. 84.

Dr. Nathan R. Smith, of Baltimore, has introduced a splint for fracture of the thigh, which no doubt will answer for simple or compound injuries. It is a double-inclined plane, made of wire, and intended for suspension. The splint is placed above the limb instead of underneath.

It is composed of a frame made of stout wire (size No. 10), (fig. 85). Its length should be sufficient to extend from the anterior-superior spinous process of the ilium, to a point beyond the toes, the lateral bars being separated 3 inches at the upper end, and 2¾ inches at the lower end. Before being used it is covered with cotton cloth, to protect the limb from immediate contact with the wire. The limb is then secured to the splint by successive turns of a roller from foot to groin (fig. 86).

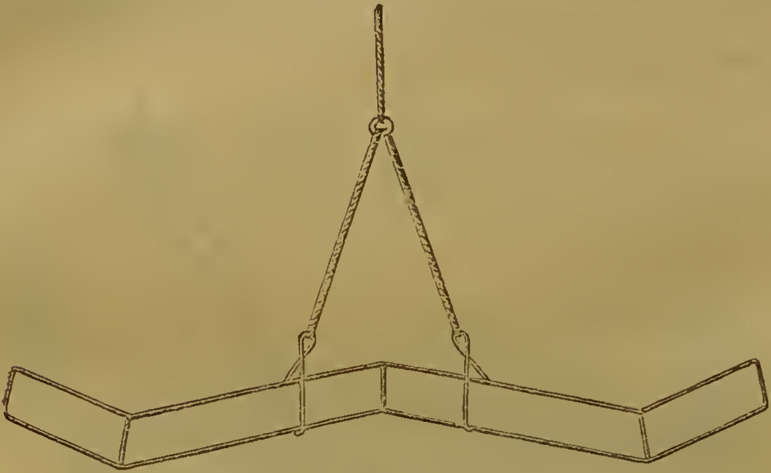

Fig. 85.

When this splint is applied to a broken femur, one of the hooks, to which the suspending cords are attached, should be made fast to the splint about opposite the seat of fracture, and the other should be secured a little above the middle of the leg; while the point of attachment in the ceiling, or to the frame from which the suspension is made, should be a little in advance of the knee, and not perpendicularly above it. This will secure a certain amount of extension and counter-extension upon the thigh.

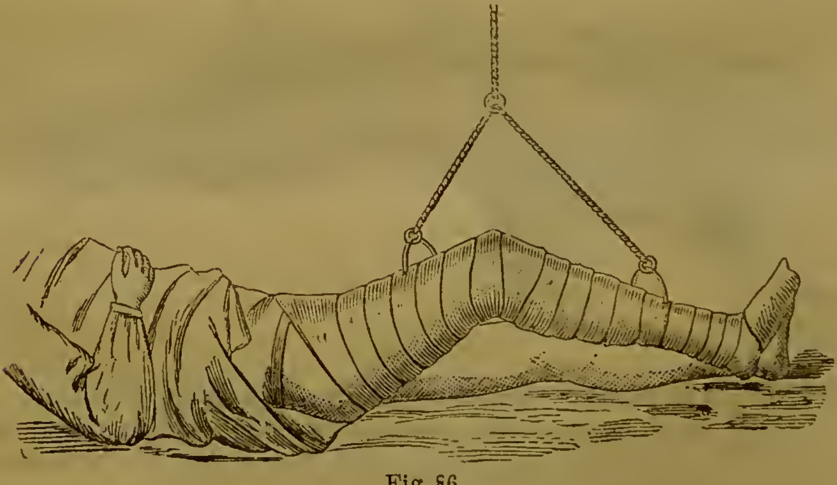

Fig. 86.

The principal objection to this splint is the difficulty of applying it and the roller from time to time, without disturbing the limb at the seat of fracture. The limb is also liable to be bent at the point of union.

Professor Esmarch, in his work on bandaging (1866), describes a splint for gun-shot fractures of the thigh, which is very easily made, portable, and can be used for placing the limb in a straight or double-inclined position. It consists of two planks, on which the upper and lower leg are to be laid, and which are united by two hinges. There is a third plank, to which the plank to support the thigh is attached by means of a hinge, and which admits of movement to any angle of the thigh and leg planks. To keep the foot firm, there are two 10-inch pegs, which, with a bandage, are connected with one another to form a foot support, so that the foot can be pressed against it. Similar, but smaller, pegs are placed on the sides of the plank, fixed on both sides, so as to keep the pads in position. If it is necessary to raise the foot, a brick should be placed under the apparatus at that end (figs. 87 and 88).

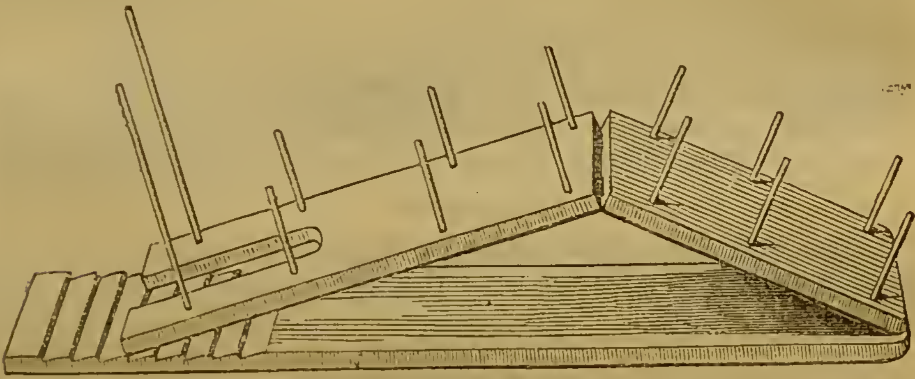
Fig. 87.

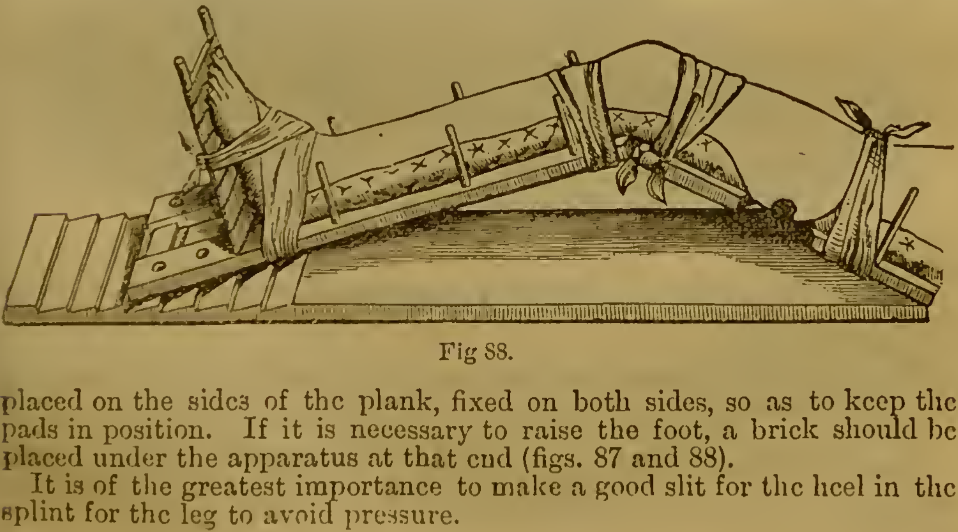
Fig 88.

It is of the greatest importance to make a good slit for the heel in the splint for the leg to avoid pressure.

In compound fractures, where the aperture exists in the posterior and outer part of the limb, Erichsen has found a long splint, made of oak, and bracketed opposite the seat of the injury, the most convenient apparatus, enabling the limb to be kept of a proper length, and the wound to be dressed at the same time (fig. 89).

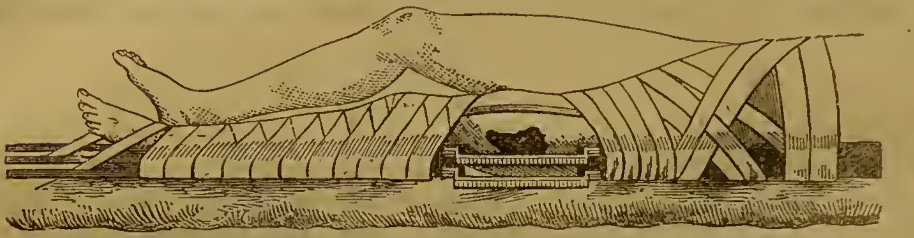

Fig. 89.

Professor Stromeyer has designed a fracture-box, which may be used for fractures of the thigh or leg, but appears best suited for the latter (fig. 90). It consists of a double-inclined plane, supported on a frame, with hinged brackets, which can be moved so as to place the box at a convenient angle.

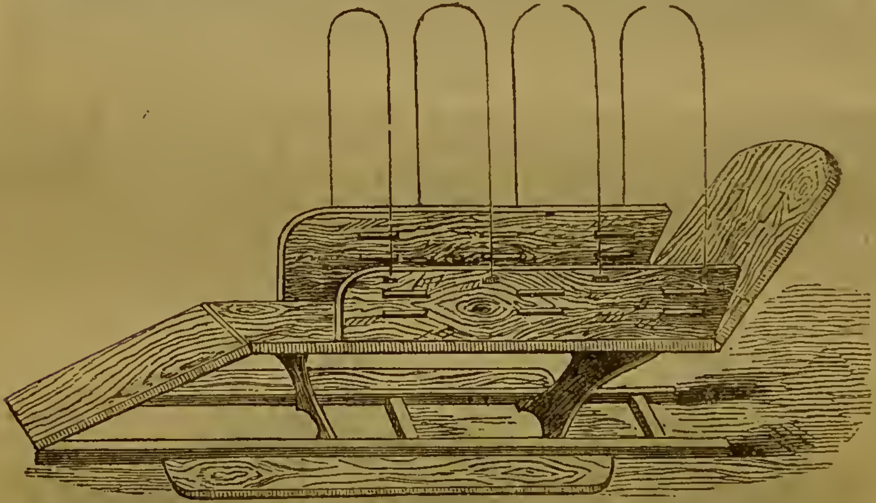

Fig 90.

The thigh-piece, sides, and foot-board are attached to the bottom of the box by hinges, and so constructed that all fold into one convenient package.

The sides and foot-board are perforated to admit of bandages being passed through. An intelligent carpenter should be able to make an apparatus of this kind in a short time.

(2.) *Gun-shot fractures of the leg-bones—tibia and fibula*—uncomplicated with injury to the great vessels and nerves, or when the knee or ankle are not implicated, admit of an attempt being made to save the limb. Splinters should be removed, and irregularities sawn off, if necessary.

Guthrie recommends that the leg should be placed in the straight position on the heel as a general rule, admitting a few exceptions.

Surgeon-General Longmore writes:—"Gun-shot fractures of the leg, when the comminution is not very extensive, when neither the knee nor the ankle-joint is opened by fissure, and the soft parts are not widely damaged, admit of conservative treatment. But when the fragments at the site of impact are dispersed and driven deeply into the surrounding tissue, when the remaining portions of the shaft are much splintered, when one of the neighbouring joints is penetrated, and especially when both bones of the leg are involved in the injuries, amputation under ordinary circumstances in field practice is the only course to pursue."

But here, too, the question of movement must be considered. If there is a daily march to be encountered, a gun-shot injury of the leg that would probably do well with rest and good antiseptic treatment, may, if continually moved, entail a fatal result, whereas an amputation would have enabled the sufferer to have reached his home alive though mutilated.

Numerous splints of different designs and composition have been invented for fractures of the leg, but all tending to the one object—that of fixture. In the field, when the sufferer may have to be moved, the plaster of Paris bandage will be found most convenient. In the subsequent treatment, when placed in a fixed hospital, he will derive great comfort from a common box splint with sides, so arranged with hinges that they can be let down to examine the wound without disturbing the limb. If the flesh wound is not extensive, the limb may be put up with the ordinary side splints with pads, and the whole placed in a "Salter's sling" apparatus.

The limb may also be placed on the double-inclined plane of M'Intyre, which appliance answers on service for fractures of the thigh as well, and with a firm bed gives great ease and comfort to the sufferer.

Mr. Hamilton* writes:—"When both bones are broken completely asunder by a rifle-ball or other large shot, the surgeon will not often find it prudent to attempt to save the limb. In general, the comminution is even greater than in fractures of the femur. If an attempt is made to save the limb, loose floating fragments must be removed and the limb placed in an easy position, being sustained by moderate lateral pressure. Neither extension nor counter-extension can generally be made to any purpose."

"It is impossible to lay down any absolute rules as to the position which the limb should occupy; sometimes the fragments will be found most at rest when the leg is made straight upon the thigh; but in the large majority of cases the position of moderate flexion will be required, the limb either resting upon its side, as recommended by Pott, or upon its posterior surface, as is most generally practised. Whatever form of apparatus may be used, the foot will require always the support of a foot-board, and the heel must never be permitted alone to sustain the weight of the foot."

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* *Treatise on Military Surgery*, p. 414.

(3.) *Wounds of the Foot and its Bones.*—The bones of the foot, when injured by rifle-ball or other missile, present, as a rule, serious complications, owing to their being numerous, of soft texture, and liable to run into a state of caries from the slightest injury.

There may be injury of some of the many tendons, of the vessels, nerves, and strong fascia.

It is difficult to extract splinters or foreign bodies, and, if the injury to the bone is extensive, an attempt to save the foot is not recommended, as the disease produced will ultimately render amputation necessary, which, if done at first, would prevent much suffering. When it is decided to interfere by operation, the foot, or part of it, should be removed as soon as possible. The importance, however, of preserving the heel either by Syme's or Pirogoff's operation cannot be exaggerated.

A missile will sometimes lodge in one of the bones of the foot, doing but slight injury to the surrounding textures. An attempt should then be made to remove it or the bone.

Shot Wounds of the Os Calcis.—The heel may be struck by cannon-shot or bullet, only destroying a portion of the os calcis. By due attention in removing spicula of bone and making free openings for the exit of matter, the limb may be preserved.

Wounds of Bones of the Toes.—In wounds of the bones of the toes, only such as are extensively fractured should be amputated. Much can always be done by removal of splinters of the bone, or foreign bodies, and by strict antiseptic treatment. Wounds of toes, however, are generally in connection with other injuries to the foot. It is of the utmost importance to preserve the big toe even when circumstances necessitate its being the only one that can be saved.

WOUNDS OF JOINTS.

In the treatment of gun-shot wounds of joints, much of the success will depend upon the size and description of joint, the extent of injury done, the age and constitution of the sufferer, and the time after receipt of injury that treatment has been commenced, and the available means for carrying out that treatment.

Patients who have undergone excision or resection require constant care and attention, abundant cubic space, and pure air; every facility for securing cleanliness, proper dieting, nursing, surgical skill, and most perfect rest. The suppuration, as a rule, is always copious, and there is great susceptibility to pyæmic poisoning. It is, therefore, necessary to calculate as to the possibility of securing favourable conditions before resection or excision is selected in preference to amputation—this latter operation not requiring the same amount of attention in the after-treatment, or the same prolonged rest and confinement indoors.

Professor Hannover, of Copenhagen, is not favourable to the operation of resection of joints. In his writings, he says that he has formed his opinion on the cases he has seen among the Danes who were wounded during the war between Germany and Denmark in 1864, and being one of the members of the Pension Committee, has had an opportunity of annually inspecting these cases. "In the majority of instances the patients reported to be cured were left with useless dangling limbs, and the Danish surgeons, as well as the patients, both agree that amputation would have been preferable; for it would have saved the latter from being burdened with limbs which are not only cumbersome and powerless, but also sources of frequent pain, atrophy of the extremity in which the resection has been performed, coldness, numbness, and contractions." *

Professor Hannover's remarks have been reviewed, and the reviewer naturally points out that most surgeons must be familiar with some cases in which not only full use of the hand and fingers has been retained after resection of one of the large joints of the upper extremity, but considerable power in certain movements of the whole limb. Even one such successful instance is sufficient to annul a general condemnation of the operation itself.

The late Dr. Loeffler, of the Prussian Medical Military Service, who operated in some of the cases referred to by Professor Hannover, has stated that in various instances the Professor relied upon certificates furnished by surgeons in different parts of Denmark, not for scientific purposes, but with the object of showing the necessity for a continuance of the pension to the invalided soldiers who had been the subjects of the wounds which led to the operation of resection.†

It is quite possible, as Dr. Loeffler suggests, that the same attention may not have been given to the after-treatment as in Germany, and that the climate of Denmark is not very favourable for patients after resection.

Mr. Erichsen, in his valuable work on surgery, gives the following as indications for excision:—

1. Excision may be required in bad compound dislocations and fractures into joints, especially in gun-shot injuries, more particularly in those of the head of the humerus and of the elbow.

2. As a substitute for amputation in cases in which the joint is so extensively diseased that the patient will be worn out by the discharge or pain unless it be removed. Here a useful limb may be secured by the sacrifice of the diseased part.

3. In some cases of articular disease, in which amputation would not be justifiable, excision may be performed in order to hasten the cure, and thus to save years of suffering to the patient.

4. Excision may be performed in cases in which amputation is not practicable, as in disease of the hip-joint or of the temporo-maxillary articulation.

5. As a substitute for other and less efficient treatment, in order to restore the utility of a limb or joint, as in osseous anchylosis of the elbow, or in faulty osseous anchylosis of the knee.

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* *British Medical Journal*, January 15, 1870.

† *Ibid*, May 28, 1870.

If the injury to the joint is not of such a nature as to require amputation or excision at once, it probably may be saved if free incision is made into it, all small loose fragments of bone or cartilage removed, and the cavity well washed out with a corrosive sublimate lotion (1-500), drainage tubes inserted, and the part covered with a dry absorbent dressing and rendered as immovable as is possible. In about three weeks or earlier, Cheyne recommends passive motion to be begun.

WOUNDS OF THE SHOULDER-JOINT.

All wounds of the soft parts in the proximity of the shoulder-joint are deserving of the greatest consideration. Neudörfer specially remarks on this, and says: "It occurs that wounds which do not open the joint primarily injure the same to such an extent, that in a short time complete suppuration of the joint ensues." An obscure case of this group occurred in a soldier of the 23rd Regiment, who was wounded during the Ashantee expedition of 1874. A leaden slug entered the head of the left humerus, without fracturing the bone, or opening the capsule of the joint, or causing much primary irritation; five months subsequently inflammation and suppuration of the joint set in, for which I* performed excision of the head of the bone. (See *Army Medical Reports for* 1873.)

Should the joint be laid open by a sabre cut, or slightly wounded by a rifle bullet, the soft parts not much lacerated, no large vessel or nerve wounded, and the constitution of the sufferer good, the wound ought to be well washed out, a drainage tube inserted, so that, by careful attention and dressing, and keeping the limb at perfect rest, recovery may take place. Should the head of the humerus be splintered, the articulating surface injured, the soft parts only slightly damaged, and no wound of great vessel or nerve, the operation of excision is advocated, which, in the hands of British surgeons, has been found most successful, and has given the sufferer a comparatively useful limb.

Sir T. Longmore records, during the Crimean War, that of thirteen resections of the shoulder-joint in the English army, there was only one death; eight of these were primary and five secondary operations; and that, during the New Zealand campaign, several resections were performed with remarkably successful results.

Partial excision of the head of the humerus may be performed, but the results heretofore have not been altogether satisfactory. In the reports of the American War, fourteen cases of partial excision are recorded, in seven of which the arm was useless. In the same reports cases are given in which 3, 4, 5, and even 6 inches of the shaft of the humerus as well as the head were excised, some of the patients recovering with fair power of the hand and forearm, and others without any impairment. Mr. Otis, in analysing the treatment of 2,328 cases of wounds of the shoulder-joint, arrives at the following conclusion:—

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* Porter.

1. That in slight shot injuries of the shoulder-joint an expectant conservative treatment is justifiable.

2. If a ball is impacted in the head of the bone, or if the epiphysis is much comminuted, unless there is injury to the blood-vessels and nerves, or very grave injury of the other soft parts, primary excision should be practised.

3. Concomitant fractures of the acromial end of the clavicle, or of the neck or processes of the scapula, or of the upper third of the shaft of the humerus, do not necessarily contra-indicate excision of the shoulder.

4. Intermediary excisions should seldom or never be practised. If, in an attempt at expectant conservative treatment, intense suppurative inflammation arises, it should be combated by free incisions, drainage, antiseptic applications, &c., and every endeavour should be made to avoid inflicting another wound upon the inflamed medullary tissue, and to await the second stage before undertaking operative interference.

5. The after-treatment of securing comparative immobility and support of the limb and efficient drainage of the wound, and the ulterior after-treatment of judicious passive and active movements of the arm, are of essential importance in restoring the functions of the member.

WOUNDS OF THE ELBOW-JOINT.

Punctured and incised wounds of the elbow may usually be treated on a conservative plan, with every hope of recovery, reserving secondary excision until rendered necessary by inflammatory disorganisation. The bones forming the elbow-joint may be slightly injured by sabre cut, bullet, or fragment of shell. In the event of the external wound being slight, and the bone only partially damaged, that is, splintered about the condyles, olecranon, or radius, or if a bullet or other foreign body is lodged in the lower end of humerus or condyles, it will be necessary to remove all loose splinters, to extract the foreign body, to wash out the wound, and to follow a strictly antiseptic treatment. The joint will in all probability be stiff, but the patient will have the advantage of a forearm and hand; and here it is that experience may do so much in saving a wounded soldier from excision or amputation. By careful examination with the finger immediately, or as soon as possible after receipt of injury, the exact condition of the joint may be ascertained, and the necessary operative measures at once carried out.

Guthrie observes: "When the articulating ends of the humerus, radius, and ulna are wholly or in part injured by a musket-ball, it was formerly the custom to amputate the arm in such instances of great mischief; an operation which should be superseded by that of excision of the joint."

Excision of the elbow-joint, in the hands of British military surgeons, has been attended with most happy results. The writer* has seen some useful limbs after the operation, capable of lifting weights, and unaccompanied by pain or numbness.

The Period of Election for Excision of the Elbow.—We have it on the authority of Heyfelder and other experienced surgeons, that, as in amputation after shot wounds, a favourable result of the operation is so much more to be expected the earlier the resection is performed.

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* Porter

Amount of Bone to be removed in Resection.—By the experience recorded in the reports of the American War, the doctrine has been confirmed that complete resections give more favourable results, both in preserving life and utility of limb, than partial ones. The removal of the head of the radius, or of one of the condyles, or the upper extremity of the ulna, is more liable to be followed by inflammation, extensive and prolonged suppuration, or by anchylosis, than the removal of the entire joint. Some doubt, however, exists as to such line of treatment when the joint is exposed, the ligamentous attachments freely divided, and the injury is confined to the lower end of the humerus. Is it safer to saw off the injured extremities of the radius and ulna, or if the joint ends of the bones of the forearm only are injured to remove the condyles of the humerus?

In disease Mr. Syme recommended the removal of the articular extremities. In operations for injury, Mr. Otis appears to consider *a priori* that there is not the same need of inflicting additional injury by a section of healthy bone, and the deduction seems to be sustained by facts, excellent results having been obtained when the joint ends of either the upper or forearm have been removed after complete exposure of the joint, and the uninjured portions of the articulation have been unmolested.

An interesting and instructive case is recorded by Sir W. MacCormac (*British Medical Journal*, January 22, 1876), in which a soldier during the Franco-German War received an injury of the shoulder and elbow on the same side, in which he excised both joints with most satisfactory results.

WOUNDS OF THE WRIST-JOINT.

The wrist being a complicated joint, gun-shot injuries to it are liable to be followed by most serious results, and, as the structures are so superficial, *resection as a primary operation* is not likely to be successful. Its close connection with flexor and extensor tendons renders them liable to consolidation with their sheaths, and thus to cause stiffness of the joint.

Sword cuts opening into the joint, if seen early should be cleaned, the soft parts and all tendons brought together by means of sutures, and the hand and forearm supported on a splint, until firm union has taken place, when flexion and extension should be exercised to try and avoid a stiff joint.

M. Legouest makes the following important observations regarding recent wounds of the wrist:—Shot fractures of the wrist, where the region is traversed in its long diameter, and is the seat of much shattering (*délabrements*), require amputation in the forearm. Where the joint is perforated from before backwards, without great disorders, by extracting splinters the limb may be preserved.

Of six complete excisions of the wrist during the American War, one proved fatal after recourse had been had to amputation. The five others recovered with the functions of the hand much impaired, but, all things considered, in a better condition than if they had been subjected to amputation.

Sir J. Lister has endeavoured, with most happy results, to render the operation of excision of the wrist successful, and his operation should, if practicable, be selected, being least liable to injure the important structures near the joint. His recommendations for after-treatment should be attended to.

The Expectant Treatment.—In selecting cases for this method of treatment, the surgeon must be guided by the amount of destruction of soft parts and bone, bearing in mind M. Legouest's practical hints. From the experience of the American War, injury of one of the large arteries complicating these fractures, was not always regarded as an absolute counter-indication of expectant conservative treatment. In 707 cases treated on the expectant method, confined abscesses occupying sheaths, bursæ, and synovial sacs, and leading to extensive adhesions and contractions, were amongst the most frequent complications.

The wound should be treated by the strictest antiseptic methods, and the parts should be supported without constricting bandages, upon a padded splint. Free incisions should be made when suppuration has taken place, and movements of the fingers and hand should be commenced as early as practicable.

When the wrist is so severely injured as to preclude all hopes of saving it, amputation through the joint may be had recourse to.

In applying bandages to the wrist, the fingers should be left free, and occasionally moved to prevent anchylosis.

GUN-SHOT WOUNDS OF THE HIP-JOINT.

These wounds are without doubt the most dangerous of all joint wounds. They are difficult to recognise; they are frequently not discovered through want of proper care, and the immobilisation of the joint, which is the chief requisite for successful treatment of joint wounds, is more difficult to carry out than with any other joint.

Military surgeons in former days looked upon gun-shot wounds of the hip-joint as simply hopeless, and considered that the wounded died, except in very rare cases, just as much after one mode of treatment as after the other. Mr. Hennen makes these observations:—"Injuries occasioned by balls lodging near or about the joint of the hip are amongst the most serious in military surgery; the fever, the profuse discharge, the tedious exfoliation, all tend to sink the patient, and are but too often fatal. In some of these the course of the ball is so obscure, and its place of lodgment so uncertain, that it can only be detected after death." These remarks entirely bear out the experience of most surgeons of the present day, but the mortality statistics of the Franco-German War of 1870-71, give evidence that hip-joint injuries are not absolutely hopeless, and an endeavour should in consequence be made to try and bring about more happy results, either by judiciously conducted conservative treatment in properly selected cases, by excision of the joint, or removal of splinters, or by amputation.

Professor Langenbeck* has pointed out a mode of determining the situation of the hip-joint. "It is known that the position of the hip-joint may be demonstrated, if we construct a triangle whose base intersects the trochanter major, while the femur and the anterior-superior spine of the ilium form the points of an acute angle. If the entrance or exit of the shot is within the compass of the triangle, or if the direction of the shot canal falls within this space, then the hip-joint will probably be implicated. The joint will be most directly involved when the bullet penetrates close below the anterior-inferior spinous process, or nearly $1\frac{5}{8}$ inch below the anterior-superior spinous process, and in the direction of the median line. The spongy part of the head of the femur will be injured in such a case, and, as a rule, smashed to atoms. If the entrance of the bullet be close below and external to the spine of the pubis, and if its exit be in the region behind the trochanter major of the same side, as a rule, the hip-joint will be implicated with probable separation of the edge of the acetabulum. When the entrance and exit wounds are in front or behind the trochanter major, injury to the neck of the femur, with openings of the hip-joint capsule may be assumed for certain."

Conservative Treatment.—Langenbeck has also pointed out that some gun-shot wounds of the hip-joint, and even most severe cases, may be cured by conservative treatment; that the surgeon should decide after the first examination if conservative treatment be admissible, or if operative interference must be resorted to; hip-joint wounds should therefore be quickly recognised, or weighty difficulties offer themselves; and whatever plan of treatment is adopted, it should be carried out in a rational manner from the moment of injury. He gives 88 cases of gun-shot wounds of the hip-joint, treated conservatively during the Franco-German War of 1870–71, in which 25 were cured and 63 died, equal to 71·59 percentage of deaths, against 31 treated by resection and extraction of the head of the femur, in which 4 were cured, 26 died, and 1 was doubtful, equal to 73·87 percentage of deaths.

For conservative treatment he first selects all the lighter hip-joint injuries, in which it is impossible to determine the exact diagnosis directly after wounding. He lays great stress on the importance of conservative treatment, even when the bladder and rectum are implicated, or complicated injuries of both organs exist. According to Langenbeck's way of thinking, conservative treatment should not be adopted, either for intra- or extra-capsular fractures of the neck of the femur, if the continuity of the bone is quite destroyed.

As recovery from these wounds hardly ever occurs without suppuration in the joint, consolidation of the fracture must be looked upon as impossible, and necrosis of the head of the femur, at all events in intra-capsular gun-shot fracture, as unavoidable. We must, therefore, he says, consider that complete separation of the neck of the femur and splintering of the head and neck of that bone should be excluded from conservative treatment, and that resection or extraction of the head should be performed either primarily before the expiration of the first twenty-four hours, or directly after the expiration of the infiltration period, and before suppuration commences.

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* *Surgical Observations on Gun-shot Wounds of the Hip-joint*, by B. von Langenbeck. Translated by T. F. West, F.R.C.S.

To carry out conservative treatment with the possibility of success, Langenbeck considers that the first and most important task is the immobilisation of the joint, and the suitable position of the patient. The wounded should therefore be left in the nearest field hospital, the first immovable bandage should be applied on the battlefield, and so arranged that the probable unavoidable further transport to the first station of the army hospital, and perhaps on a railway ambulance waggon, may be undertaken without great injury to the wound.

A plaster of Paris bandage well put on, surrounding the pelvis and the entire extremity, would best answer these requirements, but as they are troublesome of application, and require much time and too many experienced hands, Langenbeck does not recommend them during a great battle, but suggests flat hollow splints, passing round the back of the pelvis and of the entire wounded extremity, leaving the fore part of the hip-joint free. He also speaks in favour of the "zinc tablets" suggested by Dr. Schön of the Austrian army.

Permanent extension by means of a weight is of the greatest importance. Active probing of the shot canal is objectionable, especially when it has been decided to treat conservatively, as it must impair the chance of a favourable healing of the wound. With regard to extraction of the bullet, he is of opinion that if it is perceived in the neighbourhood of the joint, its extraction is necessary. Bone splinters, if they lie quite loose in the wound, may be extracted, especially if they are likely to interfere with the shot canal, or prevent the discharge of secretions from the wound. Repeated vigorous attempts to take bone splinters out of fresh wounds are altogether inadmissible. Free incisions are of the greatest importance for letting out blood which may be retained in the joint, or for collections of matter. Ice is recommended in Germany in the treatment of all recent joint wounds.

Excision of the hip-joint for gun-shot wounds was performed in the Crimea, in the Schleswig-Holstein campaigns, during the American War of the Rebellion, and during the Franco-German War of 1870-71, but the result with few exceptions was far from satisfactory, due in many instances to the want of proper means for carrying out the after-treatment. Yet till Professor Langenbeck published his experiences, as compared with conservative treatment, it was advocated for certain wounds in preference to conservative treatment, and with suitable means for the after-treatment, one cannot but think it would be preferable, seeing the splendid results which the operation sometimes affords in civil life.

Excision was first recommended by Mr. Guthrie as a substitute for amputation at the hip-joint; he limited the operation to injuries of the head and neck of the bone, or with little extension beyond these parts.

Mr. Hamilton, U.S.A., considers that when a ball has entered the head, neck, or trochanteric portion of the femur, if any surgical operation is demanded in these cases, it is excision.

Mr. Otis gives three periods for performing the operation of excision of the hip-joint.*

These periods he defines thus:—*Primary*, those performed in the interval between the reception of the injury and the commencement of the inflammatory symptoms, a period rarely exceeding in duration twenty-four hours, but it may be prolonged to thirty-six or forty-eight hours. *Intermediate*, those performed during the persistence of the inflammatory stage, a period extending over two or three months. *Secondary*, those performed after inflammation has subsided, when the local lesions have become analogous to those resulting from chronic disease.

He writes:—"A study of the history of over 20,000 major amputations and of more than 4,000 excisions of the larger joints definitely teaches that, in operations for traumatic causes, there is a wide difference in the results of those performed immediately after the reception of the injury, those performed during the existence of inflammatory action, and those done after the symptomatic fever and inflammatory symptoms have abated."

Mr. Otis says:—"122 cases comprise the greater number of gun-shot fractures of the upper extremity of the femur, involving the hip-joint and treated on the expectant plan, which were uncomplicated by lesions of the pelvis, or of the great vessels or nerves. Of these, 114 proved fatal, and the average duration of life after the reception of the injury was thirty-one days." "I continue," he writes, "to share the conviction of Guthrie and the elder authors as to the uniform fatality of such injuries when abandoned to the resources of nature. I am fortified in this opinion by the fact that none of the officers of the regular staff have ever observed an unequivocal instance of recovery under such circumstances, by the testimony also of a majority of the surgeons of the volunteer staff, and the concurrent testimony of a large number of those regimental surgeons who acted as chiefs of divisions, who aver that they have never seen a recovery from an undoubted gun-shot injury of the hip-joint treated on the expectant plan. Expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the joint can be clearly established. Experience teaches that considerable portions of the shaft may be with propriety removed with the head, neck, and trochanters in cases in which splintering extends below the trochanter minor. The necessity of accurate diagnosis cannot be insisted upon too strongly, since there can be little doubt that gun-shot fractures of the upper third of the femur, not involving the articulation, are best treated by conservative measures. In fractures or excisions of the upper extremity of the femur, no apparatus or dressing yet devised ensures entire rest under such circumstances."

All experience thus points out the necessity of excising the head and neck of the femur when completely fractured by a bullet. To attempt to carry out an expectant treatment unless the patient can be promised absolute rest for some time afterwards is to ensure a fatal result. The only course is to excise the parts within the first twenty-four hours if possible, and, therefore, the first examination should be most carefully conducted with the finger, so that accurate knowledge may be acquired of the exact nature of the injury. Antiseptic treatment, however important and valuable, will not suffice without an operation in a case of this kind if the one factor, rest, is wanting.

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* Circular 2—A Report upon Excision of the Head of the Femur. War Department, Washington, U.S.

Amputation at the hip-joint for gun-shot wounds, notwithstanding its great mortality, cannot be altogether discarded. Mr. Guthrie laid it down as a principle that in all cases of accident, whether from shot, shell, or railway carriage, no man should suffer amputation at the hip-joint, when the thigh bone is entire. Cases requiring it are—those in which a wound of the artery is accompanied by a fracture of the femur, or in the event of the principal artery being wounded during the course of treatment, or its not being possible to saw the bone through immediately below the trochanter major, and when sufficient flaps cannot be preserved to close the wound thus made.

The following rules as regards amputation at the hip-joint, which are laid down by Mr. Otis, appear highly practical:—(1) When the thigh is torn off, or the upper extremity of the femur comminuted with great laceration of the soft parts, in such proximity to the trunk that amputation in continuity is impracticable; (2) when a fracture of the head, neck, or trochanters of the femur is complicated with a wound of the femoral vessels; (3) when a gun-shot fracture involving the hip is complicated by a severe compound fracture of the limb lower down, or by a wound of the knee-joint. There are two other possible contingencies under which primary or early intermediate coxofemoral amputations for injury may be admissible:—(1) When, without fracture, a ball divides the femoral artery and vein near the crural arch; (2) when a gun-shot fracture in the trochanteric region is complicated by extensive longitudinal fissuring as to preclude excision.

Langenbeck, in refering to the dangers of amputation at the hip-joint, gives as a prime cause the lateness at which the operation is usually performed after receipt of the injury. He considers it should not be done during the period of infiltration, or after pyæmic or septicæmic symptoms have appeared, but that the proper period is in the course of the first twelve to twenty-four hours. If, however, the right moment for disarticulation is neglected, resection is admissible, as the only means of saving life, with a view to disarticulation being performed later, when the patient is in more favourable circumstances.

Symptoms of Gun-shot Fractures of the Hip-joint.—With complete separation of the head or of the neck of the femur, the symptoms are the same as fractures of the neck of the thigh in civil practice. Discharge of synovia is represented as being absent more frequently than present; this is peculiarly remarkable in wounds that go direct into the joint from the groin, but not with those where the wound aperture lies further back; the absence of synovia, however, does not prove that the hip-joint is uninjured. Langenbeck lays down as one distinct sign the swelling of the articular capsule by blood and synovia, ichor and pus, which is most plainly witnessed in the neighbourhood of the groin, where the articular capsule is superficial. The large vessels are forcibly lifted by the continually swelling capsule, so that the femoral artery seems to beat close under the skin.

Gun-shot wounds of the trochanter, and injuries of the soft parts near the hip-joint, require the greatest care, even when there is no evidence of the joint being injured, because the subsequent inflammation and suppuration may ultimately extend to it. The trochanter major, remarks Professor Langenbeck, as the projecting point in the outline of the thigh, shows the centre of the hip-joint, so the bullet may lodge in the joint if it is projected in that direction. The dilatable bone substance allows the bullet to press forward into the joint without leaving behind a shot canal that will fairly admit the probe, and one is too easily led to believe that the ball has passed through or fallen out of the apparent shot canal.

It is now considered good practice in gun-shot wounds of the upper part of the femur, when the fracture does not extend beyond the trochanter or is in the trochanter itself, to simply remove the splinters and secure absolute rest for the patient.

Wounds of the Knee-Joint.

Wounds of the knee-joint are most serious. The admission of air into a large sac, lined by synovial membrane, producing septic inflammatory action, the missile probably injuring the cartilage and bony structures, the drain on the constitution by profuse suppuration, with, in all probability, diarrhœa and hectic from septic blood-poisoning, render these injuries beyond hope of recovery without surgical interference, unless treated antiseptically from the first. The treatment generally hitherto admitted as being the best is that of amputation, but there are surgeons who advocate resection.

Mr. Hennen, after his great experience, says: "In my own practice I have met with only two cases where the limb was saved after serious injury to the knee-joint, and in one of them only was the perfect use of it restored."

Mr. Guthrie considers that "wounds of the knee-joint from musket-balls, with fracture of the bones composing it, require immediate amputation."

Dr. Macleod, who appears to have taken a special interest in this class of wounds, visited every one he could hear of in camp while in the Crimea, and avers that he never met with one instance of recovery in which the joint was distinctly opened and the bones much injured by the ball, unless the limb was removed.

Dr. Stromeyer recommends primary amputation for gun-shot injuries of the knee-joint. He is not in favour of resection, and is thus opposed to Professor Langenbeck, whose system is non-interference.

Langenbeck very strongly advocates conservative treatment. Immediate amputation or resection he reserves for cases where fragments of bone are actually severed, or where shattering of the bone ends is complicated with considerable tearing and loss of soft parts. He uses plaster of Paris bandages, ice, and antiseptics. In 1866, out of 18 cases, 11 were cured by conservative treatment.

Dr. Carl Reyher in the last Russo-Turkish War had a remarkable success, he divides his cases into "primary antiseptic," that is cases which were treated aseptically from the first, and which had not been *fingered* or probed in any way. "Secondary antiseptic," or cases where the wound had been examined or treated in some way opposed to aseptic principles, and "non-antiseptic" cases. He had 46 cases of gun-shot injury to the knee-joint, 18 were primary antiseptic cases, of which 3 died, and 15 recovered with movable knee-joints—percentage of mortality 16·6. Forty were secondary antiseptic, 34 died, 1 recovered—percentage of mortality 83. Twenty-three were non-antiseptic, 22 died—percentage of deaths 95·6.

In his primary antiseptic cases, Reyher either washed out the wound, if small, with an antiseptic solution, removed any foreign body present, drained and treated it by a dry gauze dressing; if, however, the apertures were large, and splinters of bone had to be removed, he carried out Lister's treatment with all details of gauze, spray, &c.; or he did not wash out the wound at all, but simply contented himself with purifying the exterior and applying an antiseptic dressing. The former practice was adopted when the wound was gaping, and when there was a suspicion that portion of the clothing, &c., had been carried in with the bullet; the latter practice, where the edges of the skin were lying together, and where it was thought that the bullet had not carried any extraneous matters in with it. Bergmann also got some remarkable results. He had 15 cases of fresh gun-shot wounds of the knee-joint after the storming of Telisch and Gorni-Dubnik. These were all treated by careful cleansing of the skin by a carbolic solution, and then applying masses of salicylated wool, and over all a plaster of Paris bandage. Of these 14 recovered, 2 after amputation, and 1 died.—*Cheyne.**

Surgeon-General Longmore sums up from all the experience gained regarding gun-shot wounds of the knee-joint, that when the damage is slight, and early immobilisation and antiseptic treatment can be carried out, conservative treatment should be adopted. When, however, these cannot be obtained, and when the patients are liable to be moved frequently, or to long distances, hurriedly and without adequate protection, and when the injury is excessive, amputation above the joint is the only remedy.

"In all cases in which antiseptic treatment is impossible, conservative treatment contrasts most unfavourably with primary amputation in the lower third of the thigh. When amputation is determined on, the operation requires to be performed early, and this necessity for early amputation in penetrating bullet wounds of the knee-joint when antiseptic treatment is impossible, is recognised by all modern military surgeons."—*Erichsen.*

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* *Antiseptic Surgery.*

Excision of the knee-joint is an operation which should not be attempted unless under the most advantageous circumstances; when every possible care and attention can be given to the after-treatment; when the patient can have good air and diet, and every appliance that the surgeon may require, together with absolute rest. These circumstances are not likely to exist in the field, though they may be available in stationary hospitals in European warfare.

If an attempt be made to save the limb without operation, the joint should be thoroughly washed out by a 1-20 carbolic or other antiseptic lotion, thorough drainage, either by tubes or fresh incisions, and the whole joint enveloped in salicylated or mercurialised cotton wool, and the limb should be immobilised on a splint.

But if, from the nature of the injury, an operation is deemed necessary, the safest course to adopt is to amputate at the lower third of the thigh, and the sooner it is done the better, as inflammatory symptoms soon set in after such injuries, followed by suppuration of the joint; abscesses appear among the muscles of the thigh, burrowing along the bone after depriving it of its covering; the patient rapidly becomes exhausted by hectic, when interference by amputation will be too late.

In incised wounds of the knee-joint, if not complicated, it is best to try and save the limb by enlarging the wound if necessary, thoroughly washing out the joint with an antiseptic lotion, providing for complete drainage, enveloping it in an antiseptic dressing, and rendering the limb immovable by splints; should, however, inflammation set in and pus forms, free exit must be given to the matter, and the most careful antiseptic treatment by frequent washing out with mercuric chloride, or other antiseptic lotion, must be carefully attended to.

WOUNDS OF THE PATELLA.

The patella is occasionally fractured with a bullet or other missile, and if complicated with injuries to the other bones it will be impossible to save the limb. Should, however, the patella be struck in front and only split, an attempt should be made to save the limb.

If antiseptic treatment is available, the fragments may be wired together with the same successful results as attend the operation for ordinary fracture, but any liability of the patient to sudden or frequent moves would render the treatment difficult.

In all injuries to the patella, the limb should be placed in the straight position, with a well-padded splint underneath, and heel slightly raised.

WOUNDS OF THE ANKLE-JOINT.

In these injuries much depends on the amount of damage done to guide the surgeon in the treatment. If the bones are not extensively injured, and the posterior artery and nerves intact, an attempt should be made to save the foot; but, like all injuries to joints in which the surgeon might wish to save the limb, and indeed where it might be considered advisable, the circumstances as regards rest, care, attention, &c., as already described, should influence him.

Stromeyer, in wounds of the tibio-tarsal articulation, recommends the expectant treatment. He is opposed to resection of this joint, which was not successful in the Franco-German war of 1870-71. His plan of treating gun-shot wounds of the ankle is simply to keep the parts perfectly immovable, and extract the pieces of splintered bone as they become detached.

Langenbeck is in favour of resection, which operation he performed with success in the German-Danish War of 1864, and the Bohemian War of 1866. He has had nine recoveries out of eleven operations. He recommends subperiosteal resection, and complete immobilisation of the parts after the operation.

Erichsen considers that if the bones be not too extensively comminuted, an attempt, and probably a successful one, may be made to save the limb. In such cases extraction of fragments and excision of the splintered ends are necessary; and modified operations, partial excision by means of gouge, forceps, and Hey's saw, will be found more successful than the formal operation.

If the large vessels and nerves have been cut across, and the bones very extensively shattered, amputation will be the proper course to pursue.

Legouest admits that there are many instances of success when resection of the ankle-joint has been performed, but considers that the seriousness of lesions of this articulation, the danger of the operation, and the uncertainty of definite results, justify him in rejecting resection of this joint in a general way, as he has already rejected that of the wrist.

WOUNDS OF NERVES AND TENDONS.

Nerves may be injured by contusion, compression, or distension, by laceration, by partial or whole division, by puncture or incision. Foreign bodies may be imbedded in them, or they may be included in a ligature, any of which may give rise to most serious symptoms, both local and constitutional—such as intolerable pain, inflammation, contraction of muscles, or tetanus.

Treatment.—If exposed, the parts must be thoroughly cleansed, the ends of the nerve, if divided, accurately brought together by catgut sutures, and every endeavour made to get union by first intention.

Compression of nerves, as from the pressure of tumours, aneurisms, dislocations, fractures, and the contraction of cicatricial tissue, is apt to set up neuritis. The effects of pressure may lead to loss of sensation and paralysis, wasting, and degeneration of muscles; in the course of time, however, the nerve may recover its function. Neuritis, if once set up, is very troublesome; its symptoms are described by Erichsen as intense pain and tenderness in the line of the affected nerve; sensation is variously modified in the parts supplied by the nerve; there may be numbness or tingling or anaesthesia, in other cases there may be intense pain; occasionally there are spasms, but more commonly there is weakness or paralysis of some of the muscles supplied.

The tender nerve should be freely blistered and the affected limb put at rest. Constitutional conditions, as gout, rheumatism, malaria, and syphilis, must be duly treated—it is in these cases that nerve stretching has been attended with success. By the stretching the conducting power of the nerve is abolished, but the continuity of the nerve is not destroyed, and restoration of function gradually returns.

The local application of belladonna, chloroform, aconite, blisters, subcutaneous injection of morphia and of sulphate of atropia in the proportion of $\frac{1}{2}$ gr. and $\frac{1}{25}$ gr., the administration of mercury, or division of the nerve may be tried. The local use of cocaine in a 4 per cent. solution might be of use.

Tendons may be divided by sword-cut or other sharp weapon, or ruptured by over-exertion, when it will be necessary to place the limb in such a position that the muscles may be relaxed, and so approximate the divided ends. In a wound, the ends should be carefully brought together with catgut sutures, and great pains taken to obtain union by first intention.

When the tendo-Achillis has been cut or ruptured, an apparatus may be constructed by placing a strap, like a dog-collar, above the knee, from which a cord is attached to a loop in the back of a shoe or slipper; by tightening this cord the muscles are relaxed.

When the extensor tendons of the fingers are divided, the hand must be placed in the straight position on a splint.

ANÆSTHESIA.

Chloroform.—The use of chloroform as an anæsthetic in mitigating the sufferings of wounded men and of patients undergoing operations, has been admitted by all as one of the greatest blessings.

When possible, it should be administered for all operations, and for dressing wounds when the subjects are very sensitive, the usual precautions being adopted as regards the wishes of the patient, the condition of the circulation, respiration, and having at hand means for using artificial respiration, galvanism, ammonia, and a forceps or hook for drawing the tongue forward. The experience of the writer* is that recently wounded soldiers are very easily placed under the influence of chloroform, much more so than chronic cases, and that it decidedly relieves the nervous shock. Recently wounded men require no preparation for its administration, but in chronic cases it is always best not to give food for two or three hours beforehand; but a little stimulant, such as wine or brandy, may be given about half-an-hour before the chloroform is administered.

As a guide to complete anæsthesia, Byrant lays down the rule that, "when the upper eyelid can be raised without muscular resistance, and no muscular contraction is caused by touching the cornea, the patient is, as a rule, sufficiently under the influence of the anæsthetic for surgical purposes."†

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* Porter.

† *The Practice of Surgery*, by Byrant, p. 1019.

Dr. Snow considers that "chloroform may be given with safety and advantage to every patient who requires, and is in a condition to undergo a surgical operation. A state of great depression from injury or disease does not contra-indicate the use of chloroform. This agent acts as a stimulant in the first instance, increasing the strength of the pulse, and enabling the patient, in a state of exhaustion, to go through an operation better than if he were conscious."

Chloroform and other anæsthetics should be most carefully treasured by the army surgeon, and no waste allowed. It is sometimes difficult to procure it in sufficient quantity, especially after severe engagements, when every drop is worth its weight in gold.

Ether is now much used and has obtained the credit of being much safer than chloroform. It has, however, two great disadvantages, which are, that it requires a large quantity to produce anæsthesia, also a bulky instrument for its administration—both of some consequence on active service. I * have frequently used the drug, with Mr. Morgan's, Mr. Ormsby's, and Mr. Clover's inhalers, and found it highly satisfactory.

Local anæsthesia may be induced by freezing a part, either by the use of a freezing mixture or by the rapid evaporation of ether from its surface. The former is managed by mixing some powdered ice and salt, and then applying it in a muslin bag until the skin is white and insensible—the latter by the use of Richardson's spray producer, which is a far more convenient form than the freezing mixture.

Lately, the use of cocaine has been much recommended for producing local insensibility to pain. Cocaine is an alkaloid obtained from the leaves of the *Erythroxylon coca*—its salt the hydrochlorate is soluble in water, and is used in a 4 per cent. and 2 per cent. solution. Mr. Hartridge says it is of considerable value as a local anæsthetic in disease of the cornea where photophobia is a prominent symptom, for the removal of foreign bodies from the cornea; in all operations affecting the cornea and conjunctiva only; in cases of cataract extraction where it is undesirable to give ether or chloroform. It is of little or no value in operations involving the skin. It has been used to produce anæsthesia of the larynx, pharynx, and other parts. In cases of supra-orbital neuralgia, a 10 or 20 per cent. solution in oil of cloves rubbed into the part, affords almost immediate relief. Its effects pass off in from 6 to 10 minutes. "It is a mydriatic and paralyzes the accommodation. Its aqueous solution is apt to grow fungi, and bad effects upon the eye have been attributed to these fungoid growths."—*Martindale.*

In some cases fainting and sickness are reported as following its use for purposes of local anæsthesia in eye operations.

AMPUTATION.

Under this heading will first be considered the question as to the proper period for performing amputation for wounds requiring it in warfare; secondly, cases demanding it; and, thirdly, the most approved methods of operating.

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* Porter.

Mr. Hennen remarks, in his work, 1818: "The propriety of amputation in the field being admitted, the question naturally suggests itself, What is the proper period—instantly on receipt of the wound, or consecutively? The practical reply is, with as little delay as possible."

Sir T. Longmore considers that, in respect to the particular time at which primary amputation is to be performed, the general practice of the present day is, when the operation is inevitable, to perform it as soon as it can be done, provided the more intense effects of the "shock," where it has supervened on the injury, have passed away.

Mr. Guthrie is of opinion that when the wound of an extremity is of so serious a nature as to preclude all hope of saving the limb by successful treatment, it should be amputated as soon as possible; and, further, the advantageous results of primary amputations, or those done within the first twenty-four hours, or at most forty hours, over secondary amputations, or those done at the end of several days, or of three or four weeks, have been so fully and firmly established as no longer to admit of any dispute.

In the German medical service, primary amputations are discouraged at the bandage places on the field of battle, because of the extreme difficulty in carrying out an antiseptic line of treatment in such a situation.

Amputations in warfare have for a very long time been divided into primary and secondary. Mr. Alcock has introduced a third period, "the intermediary," and these three have been accepted by many surgeons to denote periods in which amputation may or may not be performed.

He defines the three periods as follows:—Primary, or the period between the receipt of the injury and the appearance of inflammatory symptoms; intermediary, or the period when the inflammatory action has commenced, and is more or less capable of disturbing the animal economy; secondary, when the violence of the inflammatory symptoms and sympathetic fever have abated, that is, when the suppurative stage is fully established.

It is now generally admitted that when amputation is necessary, it should be performed at once, the condition of the sufferer being duly considered—that is, if the shock exists to an alarming extent, it is best to delay the operation, and administer cordials, apply warmth to the extremities, and wait till reaction is established; but if it be not very intense, the operation can be performed, under the influence of chloroform, with the most satisfactory results. Macleod remarks, with regard to the use of chloroform, that by its use the fear of intensifying the shock is obviated.

Amputations after inflammatory action has set in are generally attended by most unsatisfactory results. Operations or examination of wounds should never be performed during the intermediary state or period of inflammation, when the constitution is in a most unfavourable condition for such undertakings, and all operations are likely to be attended by the most serious results.

Secondary amputations are not so successful in military as in civil practice, when the operation is generally performed for disease and not for injury. In warfare the cases requiring it are—profuse hæmorrhage, which does not admit of the ordinary measures of suppression; gun-shot fractures, when the bones do not unite, and the patient is worn out with suppuration, irritation, necrosis, caries, and all the painful accompaniments of a shattered and useless limb; and cases when traumatic gangrene has attacked a severely contused limb.

Patients who have been subjected to secondary amputation should be placed in most favourable hygienic conditions: their constitutions having already suffered renders them peculiarly liable to the occurrence of pyæmia, sloughing, and phagedæna.

CASES DEMANDING AMPUTATION.

In wounds of the extremities these cases will be found described according to particular regions, but here they will be considered generally. *Cases demanding amputation*, then, are as follows:—

When a bone is fractured and there is laceration of the main arterial trunk supplying the limb, provided the vessel cannot be tied;

When there is a fracture complicated with destruction of the principal arterial and nervous trunks occurring in the course of a large limb;

When a whole limb is carried off, a rugged stump merely being left;

When there is a comminuted fracture, accompanied with extensive lesion of the soft parts, or with rupture of the principal artery and nerve;

When a limb is completely crushed and disorganised;

When there is a compound fracture of a large limb, with rupture of the principal artery and nerve;

When the principal vessels and soft parts have been carried away, though the bone be uninjured;

Gun-shot wounds involving the interior of the knee-joint.

Extensive injuries of the shoulder, elbow, wrist, and ankle-joints, may require amputation; but unless there is splintering into the shaft of the long bones, loss of soft parts, or injuries of the principal artery and nerve, resection or excision should be performed.

DIFFERENT METHODS CONSIDERED.

Amputation and disarticulation may be performed by the circular method, the oval method, or by flaps of different shapes, and by skin flaps with a circular cut through the muscles.

Much discussion has taken place as to which is the best plan during warfare. The circular method was generally practised by the German surgeons during the Franco-German War, and was attended by satisfactory results.

Esmarch prefers the circular incision, as the arteries are cut transversely, while by the flap operation an oval opening is made in the vessels, and it might easily occur that the whole lumen of the vessel was not included in the ligature.

The operations recommended for injuries when an army is moving are skin flaps and circular cut through the muscles. The advantages of these operations are—that the flaps are not so liable to be displaced in transport; there is less care required in the after-treatment, and it has been suggested by many authorities that the skin forms a better covering to the end of the bone than muscle, and is more in accordance with nature, none of those parts of the body where there is most pressure having other covering than the skin. The late Mr. Teale practised amputation by the rectangular flaps, the anterior being long and the posterior short. The disadvantages of this plan of operation consist in the necessity of sawing the bone at a higher point when one long flap is made, than when two shorter ones of equal, or nearly equal, length are fashioned.

In gun-shot wounds, it appears especially unsuited, as in many injuries requiring amputation good double flaps may be formed from the soft parts, and a joint saved. Take, for instance, injuries below the knee or elbow, in which, if one long anterior flap is formed, it must be at the sacrifice of the joint and the consequent increased risk to the life of the sufferer by high amputation.

In cutting skin flaps, Sir Jos. Lister particularly cautions young operators against directing the edge of the knife towards the skin in raising flaps of integument. He says,* "such a practice necessary in anatomy, will, if carried into an amputation, most seriously endanger the vitality of the flap, which derives its supply of nourishment from vessels ramifying in the fat. I am satisfied that integument designed to form a covering for the stump is often made to slough for want of scrupulous attention to this simple point." Also he says, "that the skin should always be cut perpendicular to its surface, for if it is levelled off to a thin edge it is not only unsuited in shape for adaptation with a view to primary union, but the margin may slough for lack of nutriment. Again, in transfixing a limb it is desirable that this should be done in a continuous manner, for if the instrument be thrust in for a certain distance and then partially withdrawn and made to follow a new track the punctured wound first made may cause very troublesome hæmorrhage, if a considerable arterial branch happen to be divided by it. The operator should always stand so as to be able to control with his left hand the part which he removes. In tying vessels, the catgut ligature with short cut ends has none of the inconveniences of the long threads of silk or flax formerly employed; there is no objection to tying mere oozing points however numerous. The principal veins may also be tied, as the dread of exciting phlebitis by such treatment is entirely groundless."

Mr. Heather Bigg, the experienced mechanician, in a recent work,† offers some valuable suggestions to surgeons. He says the amount of covering to be left over the end of a stump should not be excessive, for it is a rule never to take any bearing on an operative end of a stump if it can possibly be avoided. After a Pirogoff, a bearing can be entirely taken on the end of the stump, but in this case it is a natural surface and not an operative one. With amputation through the ankle (Syme's) or through the knee-joint, some bearing can generally be taken on the stump ends, although the entire weight of the body cannot usually be borne on them. Hence, whenever actual section of bones exist in the stump end, bearing cannot be taken, and a full and padded covering of muscle is useless. The greatest care should be taken in rounding the ends of the cut bone, especially in the case of the tibia and bones of the forearm.

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* *Vide* Holmes' *System of Surgery*, vol. iii.

† *Artificial Limbs and Amputations.*

Mr. Bigg, regarding stumps in the view of providing for them artificial limbs, also says:—"If possible, preserve the tread of the foot; this depends chiefly upon the great toe, with its metatarsal bone. If this cannot be done preserve the heel (Pirogoff or Syme). If this is impossible, preserve the knee with sufficient of the lower leg to utilise it, and amputate somewhere in the middle third of the leg for those who can afford an artificial foot, but for the labouring man a hand's breadth below the knee is the best suited for the bucket leg. Amputation through the condyles of the femur interferes very materially with the strength of the artificial knee, so that section through the femur just above the condyles is to be preferred."

DOUBLE AMPUTATION.

It sometimes occurs that a soldier has two limbs so severely injured that amputation of both is necessary. The writer * had an opportunity, during the Crimean War, of seeing one instance of this description of injury, in which he performed amputation of one leg above the knee, while his colleague removed the other shortly afterwards.

Double amputation has been performed at the same time by different surgeons, with a view to lessen the continuance of shock to the system, which would result from doing two operations in succession; but, to undertake anything so serious, the surgeon must be guided by the condition of the patient, as, if he is greatly depressed with continuance of the shock, the performing of a double amputation might be followed by most serious consequences. Under such circumstances, it would be better to remove one limb first, and after the shock produced by the operation had passed off to remove the other. There is no doubt, however, that if the sufferer could bear the double operation at the same time, the prospects would be more favourable.

AFTER-TREATMENT OF STUMPS.

It may be necessary to transport an unfortunate sufferer with a stump or stumps only recently made. The surgeon will then have an anxious time in so arranging that the patients are not unnecessarily knocked about. The stump should be supported by a piece of thick gutta-percha or strong board being placed underneath it and secured, and the whole enveloped in folds of cotton-wool or tow. It is surprising how soldiers recently operated upon bear transport, and what very slight injury is caused by it, due attention, of course, being paid to the nature of the conveyance and efficiency of the attendants.

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* Porter.

Sir Jos. Lister says:—"In the thigh, and also in the leg, great advantage is derived from bandaging upon the posterior surface of the stump outside the dressing, a trough of Gooch's splint (scored deal), on which the stump rests smoothly, being rendered independent of movement or irregularity of pillow."

Flies.

In camp and tropical hospitals, the greatest care is required to counteract the persistent efforts of these insects to deposit their ova in wounds, and to prevent the generation of larva in them.

Most rigid attention should be paid to the immediate removal of all dressings and bloody cloths, whether dry or recently stained; cleanliness about the patient's person, the ward, and the hospital should be enforced; particles of food should be removed, and offal and refuse buried or burnt. Wounds should be protected by light gauze thrown over the dressings. Flies fortunately have a particular dislike to the smell of carbolic acid.

Maggots in Stumps.

In warm climates maggots are very apt to infest wounds and stumps; the carbolic spray will in all probability act as a preventive to this disgusting circumstance. The writer* experienced an instance of their rapid generation in India after the battle of Sultanpore. He amputated the leg of a native in consequence of a gun-shot wound. The stump was dressed with lint moistened with cold water, and secured for transport. On the second day after the operation, a considerable journey having been performed, on proceeding to dress it, the inside presented a living mass of maggots, which were removed, and the case progressed most favourably. By keeping lint saturated with turpentine on the outer dressings, no more maggots appeared. Cresote in solution, common salt, and carbolic acid solution will expel them from a wound.

Bloodless Operation.

Professor Esmarch introduced what is known as the "bloodless operation," whereby a surgeon can remove a limb or excise a joint below the main trunk of an artery, without losing a drop of blood, and with but little assistance from others—two great advantages in warfare.

Sir Jos. Lister has somewhat modified the method of applying the elastic bandage. He has shown that an equally good result can be obtained by raising the limb straight up for two or three minutes, and gently rubbing the veins towards the trunk. "By this means the limb is rendered bloodless, both by emptying the veins and by contraction of the arteries, and then an elastic bandage can be bound tightly round the extremity at a suitable distance from the part about to be operated upon." The writer has invariably adopted this plan of late years, and in operations upon bones the convenience of a bloodless operation is very great. The objections to Esmarch's method of first enveloping the limb with an elastic bandage is that, in the case of suppuration, pus and putrid septic matter may be forced into the interstices of the sound tissues. Lister also remarks that he would hesitate in applying the continuous elastic bandage to a part affected with soft cancer. Again, the thick caoutchouc tube has, in the case of the arm, where the soft parts are comparatively scanty, produced serious paralytic effects.

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* Porter.

Without due precautions hæmorrhage is apt to occur after a bloodless operation. This, as a rule, may be checked by irrigation of the wound with iced water, by securing everything that showed a lumen, including veins as well as arteries, by exposure of the wound, or by washing it with a strong solution of chloride of zinc, or with hot iodine water.

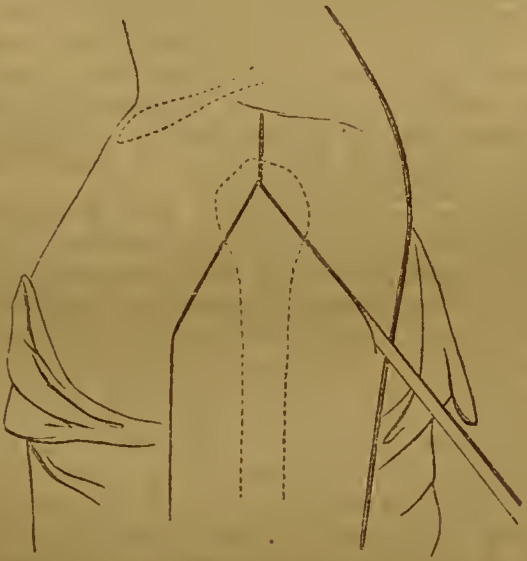

Fig. 91.

APPROVED METHODS OF AMPUTATING.

Amputation at the Shoulder-joint.—Hamilton of the U.S. Army, recommends the following proceeding :—The arm lying nearly against the side of the body, with a large bistoury or a small dissecting-knife an incision is commenced at the middle point of the extremity of the acromion process, or two or three lines above this point (fig. 91), and carried perpendicularly downwards one inch and a half, the knife being made to cut deeply until it touches the head of the humerus. At this point the knife is carried obliquely, and rather abruptly, outwards and downwards to the centre of the lower margin of the axilla on the under side of the arm ; in this second step of the incision, the tissues are divided down to the bone until the axillary margin is reached. From this point to the termination of the incision, only integuments are divided, so that we may avoid wounding the axillary artery. The knife is again introduced over the head of the humerus, at the point where the perpendicular incision became oblique, and it is carried down upon the inside of the arm in the same manner as we have described upon the outside.

One assistant pulling asunder the lips of the wound upon the top of the shoulder, while a second carries the elbow slightly across the body, and rotates the head of the humerus outwards, so as to expose the capsule and the long head of the biceps—the surgeon divides them with his knife, and at the same moment the head of the humerus springs from its socket.

The knife is then passed under the head of the bone from above, and as soon as the face of the instrument has fairly reached the surgical neck of the humerus, an assistant standing at the head of the patient pushes the thumbs of both hands into the wound above the knife, while the fingers remain in the axilla. He thus grasps and controls the axillary artery. The operation is completed by carrying the knife downwards close to the bone until the apex of the tegumentary wound in the axilla is reached, and then cutting almost directly outwards. Care must be taken not to sever the parts containing the artery until the knife has arrived at the lower margin of the axilla.

Spence's modification, which Erichsen says is especially adapted for gun-shot wounds of the upper end of the humerus, consists in carrying the vertical incision farther forward, and commencing it just external to and below the tip of the coracoid process, as in excision of the shoulder-joint. The incision ought to expose the tendon of the long head of the biceps lying parallel to it. This may be turned on one side and the joint opened and examined; and if, from the state of the parts, it be still considered necessary to amputate, the operation is completed by making an oval incision through the skin from the end of the original cut, taking care not to go so deeply on the inner side as to wound the vessels. The outer flap is then dissected up so as to enable the surgeon to get his knife internal to the head of the bone between it and the axillary artery. The assistant follows the knife with his hands and grasps the vessels, and the operation is finished by dividing the tissues left uncut at the inner side.

Amputation at the Shoulder-joint by Transfixion.—Lisfranc approved of this method, which Erichsen thus describes:—"A long narrow-bladed knife should be used. One assistant must have charge of the limb; another should raise the flap; and a third must follow the knife as it cuts behind the humerus and grasp the posterior flap with the axillary artery, so as to prevent hæmorrhage from this vessel. An assistant holding the arm away from the body, so as to relax the deltoid somewhat, the knife, instead of being entered by a puncture, should make a small cross-cut, about an inch in extent, at the point at which transfixion is to be practised, so as to prevent that jagging of the integuments by the heel of the instrument which would otherwise occur. If the operation be on the right side, the surgeon stands before the patient, and the point of the knife should be entered about an inch in front of the acromion (fig. 92), and being carried directly across the joint and capsule, should pass out at the posterior border of the axilla. If on the left side, the surgeon stands behind, and the point of the knife must be entered well behind the spine of the scapula, at the posterior border of the axilla, carried across the anterior aspect of the joint, and brought out to the inner side of the coracoid process. In either case, the large flap containing the deltoid muscle must then be cut with a sweep of the knife downwards, and, as soon as made, raised by another assistant. The heel of the knife is now to be laid on the head of the bone, the capsule of joint cut across, and the attachments of the muscles to the tuberosities divided. After the head of the bone has been turned out of the glenoid cavity, the knife must be passed behind it and carried down for a distance of about 3 inches close to the bone at its inner side. The surgeon then cuts across the soft parts, so as to form the posterior flap. In doing this, the assistant to whom this part is entrusted must follow the knife with his hands, grasping firmly the whole thickness of the posterior flap, so as to compress the axillary artery, and thus prevent the occurrence of hæmorrhage.

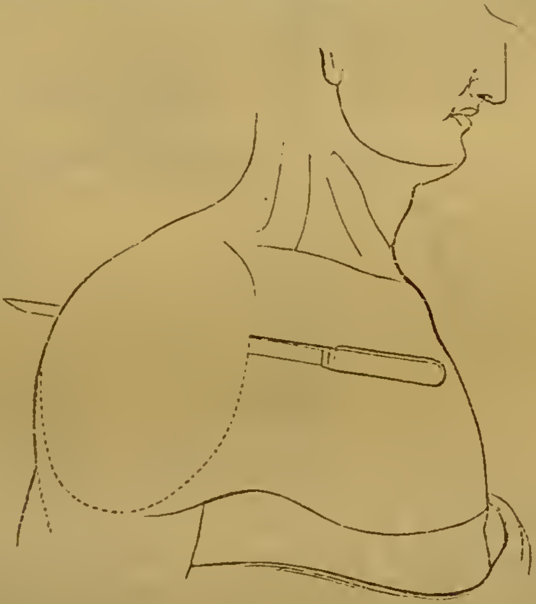

Fig. 92.

Sir. W. Fergusson recommends that a bistoury be used for these operations, instead of the more imposing-looking amputating knife; but with such an instrument the first flap on the left shoulder would be made by cutting from the skin towards the joint.

Amputation of the Arm (Circular).—"The arm being held out, and an assistant drawing up the skin, one circular incision is made through the integuments, which are forcibly retracted and detached from the deeper structures by a few touches of the point of the knife, and doubled back to the extent of an inch and three-quarters, or more, according to the thickness of the arm, another is made down to the bone (fig. 93).

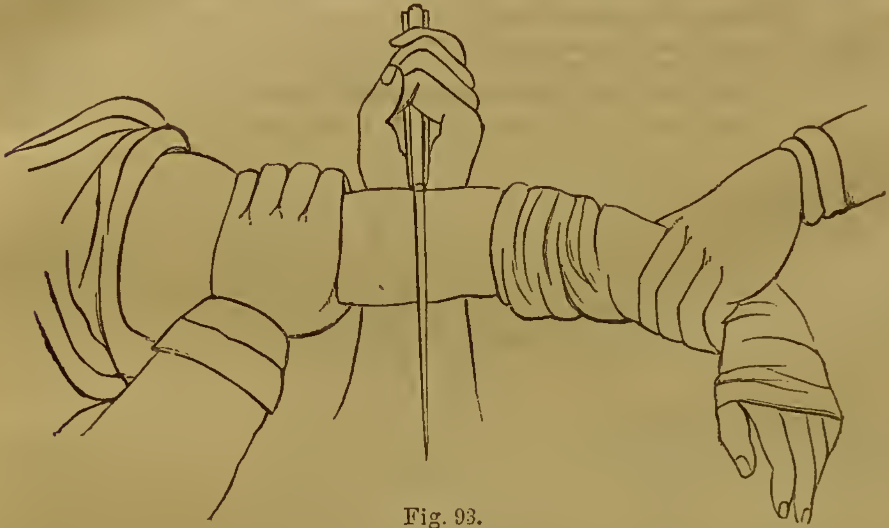

Fig. 93.

These incisions should be made with slight divergences so as to cut the skin and muscles rather longer in front and behind than at the sides."

The flap operation in the upper arm is most conveniently done by double transfixion, though the flaps may be cut from without inwards without difficulty. The limb being held away from the trunk by an assistant, the operator grasps the biceps with the brachial vessels and nerves, and draws them well up, and entering the point of the knife upwards close below the thumb, passes it in front of the humerus, depressing the point as it appears on the opposite side close to the operator's fingers. With a steady sawing movement, a flap from 2 to 3 inches long is cut, with the skin left longer than the muscles. Drawing up the flap with his fingers, the operator presses the knife behind the bone, and cuts a slightly larger flap behind, bringing out the knife abruptly at last. Both flaps being gently retracted, the knife is swept round the bone, which is then sawn through, the thumb and fingers of the left hand protecting the soft tissues. The brachial artery will be found in the anterior flap with the median nerve and the ulnar nerve will be a little posterior. The artery, if cut too long, may be conveniently shortened, and the nerves should always be drawn out and cut short by an inch or so. The inferior profunda artery will be formed in company with the ulnar nerve and the superior profunda, with the musculo-spiral nerve in the posterior flap.—*Heath.*

In very muscular arms the modified circular skin flaps, and circular cut of muscles would give the best results.

Amputation through the elbow-joint can be performed by the circular method or by flaps. If by the circular, Hamilton recommends "that the incision should commence at least 3 inches below the joint. The integuments being retracted, the head of the radius should be sought, and the external lateral ligament severed; after which, having divided all the muscles, including the tendon of the biceps and the brachialis anticus, the coronoid process of the ulna will be easily made out; the anterior ligament and capsule may now be severed more completely, then the external lateral ligament. By moderate pressure upon the forearm the joint will now open sufficiently to admit the saw, if it is thought desirable to sever the olecranon process. It is a matter of indifference, perhaps, whether we dissect out the olecranon by cutting the triceps from behind, or divide it with the saw applied as we have directed."

Flap Method.—"This is performed by passing the knife through the muscles in front of the joint, and cutting upwards and forwards, so as to make a flap from the forearm. Then the operator makes a transverse incision from behind the joint. He next cuts through the external lateral ligament, and enters the joint between the head of the radius and external condyle, then divides the internal lateral ligament, and, lastly, saws through the olecranon, the apex of which, attached to the triceps, may be left in the stump, or may be afterwards dissected out."

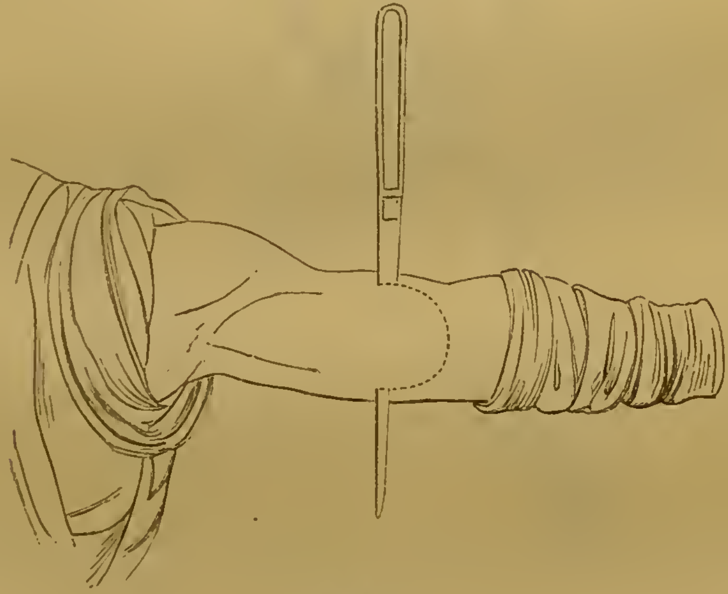

Fig. 94.

Amputation of the Forearm.—In performing this operation, as long a stump should be left as possible, so as to give the patient more power over any artificial limb that may be fitted to it. "The flaps should be about a couple of inches in length, and well rounded, the hand being placed in a mid-state between pronation and supination. The dorsal flap is best made by cutting from without inwards; the line of incision, commencing just at the palmar aspect of the under part of the ulna, being carried forward for a little distance parallel to this bone, and then across the back of the arm in a slightly curved manner, until it reaches the palmar aspect of the radius; it must then pass along this until it reaches a point opposite to that at which it commenced, and the flap thus made must be dissected back. The palmar flap is next made by transfixion. As soon as it is cut, the bones are cleared by a couple of sweeps of the knife, and the interosseous membrane is divided; they are then sawn together. The vessels are cut long at the end and on each side of the palmar flap."

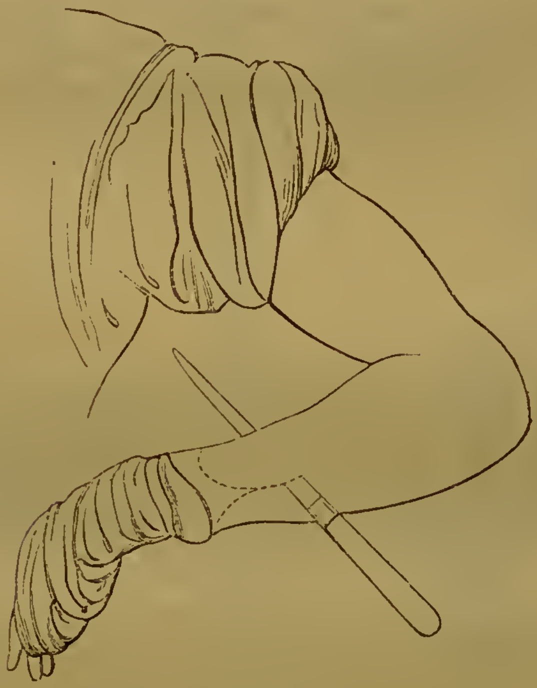

Fig. 95.

Sir W. Fergusson recommends in performing this operation, "to have the elbow slightly bent, and the hand placed in a state of pronation (fig. 95). A blade about 6 inches long should be passed from one side to the other, behind (or above) the bones; it should then be carried downwards, so as to come through the tendons and skin about an inch and a half lower down; the flap thus formed being raised, the knife should next be passed across close in front of the bones, and carried obliquely downwards, when a second flap, similar in size and shape to that already made, will be formed: both of these should now be drawn slightly upwards, and after all the textures close upon the bones have been divided, the saw should be applied close to the roots of the flaps, and the part separated."

Amputation of the Wrist (Flaps).—"A semi-lunar incision is made across the back of the wrist, its extremities being at the styloid processes, and its centre reaching down as far as the second row of carpal bones. This flap being dissected up, the joint opened behind, and the lateral ligaments cut through, the knife, being placed between the carpus and bones of forearm, is made to cut out a flap from the anterior surface of the palm (fig. 96). The pisiform bone often causes, by its projection into the palm, a difficulty in cutting the anterior flap; if not dexterously avoided by the edge of the knife, it had better be taken at the joint with the soft parts of the flap, and afterwards dissected. The nerves and tendons must be shortened, the styloid processes removed, and the skin brought together by sutures."

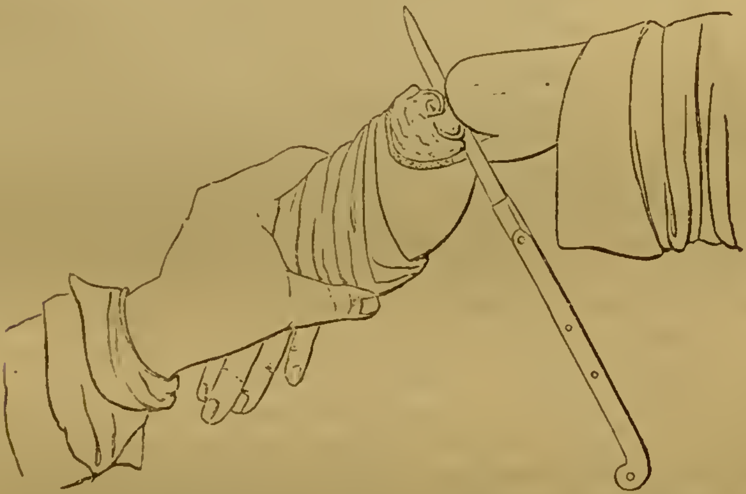

Fig. 96.

Amputation of one or more Metacarpal Bones.—No rules can well be given for incision or flaps; they must just be obtained where and how they can best be got. A single dorsal incision over the bone will allow it to be dissected out of the hand.

Amputation of Index or Little Finger.—"The knife should be applied over the back and middle of the metacarpal bone, and carried downwards

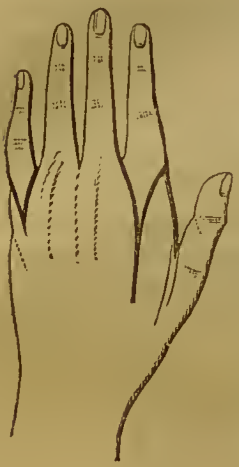

Fig. 97.

along the side and under-surface of the joint, and up again to where it was first entered, as represented by dark lines in fig. 97. After this the soft parts near the bone must be divided, and then the forceps may be used in such a manner as to cut the bone obliquely, so that there shall be no angular projection towards the skin."

Amputation of the metacarpal bone of the thumb may be performed in many different ways. The method recommended by Erichsen is as follows:—"The mode of proceeding must vary according to the side operated upon. When the left thumb requires amputation, the point of a long narrow bistoury should be introduced well on the palmar aspect of the carpo-metacarpal articulation, carried over this, which it opens, and the dorsum of the hand as far as the web of the index finger; the point of the knife should then be pushed downwards through the ball of the thumb, transfixing this, and issuing where the incision commenced. It is next made to cut outwards, keeping close to the metacarpal bone, which is readily twisted out, the remaining attachment being separated by a few touches of the knife. In amputating the right thumb, it will be necessary for the surgeon, if he adopt the method just described, either to use his left hand, or to cross his hands in an awkward manner. In order to avoid doing this, he may reverse the steps of the operation with advantage; first transfixing the ball, and making the anterior flap, then cutting over the dorsum, opening the joint, and turning out the bone."

"The metacarpal bone of the thumb may be removed through an incision on its radial margin, where the surgeon may avoid cutting either the extensor or flexor tendons. The distal extremity should first be detached from its connections, when the bone can be used as a lever whilst separating it from the other parts. The radial artery will be endangered whilst cutting some of the fibres which bind the bone to the os trapezium."

Amputation of a whole Finger.—"If the third or fourth digits require amputation, it should be performed as follows:—An assistant holds the hand, separating the fingers at each side of the one to be removed. The surgeon, holding the finger to be removed, enters the point of a long straight bistoury exactly above the metacarpo-phalangeal joint, and cuts from the prominence of the knuckle right into the angle of the web, then turning inwards there, cuts obliquely into the palm to a point nearly opposite the one at which he set out. He then repeats this incision on the other side, makes tense the ligaments, first at one side and then at the other, by drawing the finger to the opposite side, and cuts them. The tendons being cut, the finger is detached."

Amputation through the Second Phalanx.—"If the distal phalanx be so much crushed that a flap cannot be obtained, two short semi-lunar lateral flaps may be dissected from the sides of the second phalanx, which may then be divided by the bone-pliers at the spot required."

Amputation of a Distal Phalanx.—"There is no choice as to a flap, the nail preventing an anterior one; so a flap long enough to fold over must be cut from the pulp of the finger in either of two ways. 1. Holding the fragment to be removed in the left hand, and bending the joint, the surgeon makes a transverse cut across the back of the finger, right into and through the joint, cutting a long palmar flap from within outwards as he withdraws the knife. 2. Making the long flap by transfixion, it may be held back by an assistant, and the joint cut into."

Amputation at the Hip-joint.—Numerous methods have been described for performing this operation.

Sir William Fergusson recommends the following proceeding:—"The table should be stout, of a convenient height, not so broad as to prevent the surgeon and assistants being in close contact with the patient, and a folded blanket, with a couple of pillows, should be on its upper surface. The patient's breech should be brought close to the margin of the table, and the sound limb should be fastened to one of its legs. An assistant should stand immediately behind the surgeon, whose chief duty will be to raise the first flap and compress the femoral artery; another should stand opposite to hold the pelvis steady, and assist in keeping the patient's body from slipping. A third may also be useful at the shoulders to aid in this, as, from so much of the body being beyond the table, and perhaps also from the mode of operating, there is a chance of the pelvis falling over the margin; a fourth should have the limb entrusted to his care, and he, with the other who has charge of the artery, should clearly understand the intended movements of the surgeon; and the immediate and satisfactory accomplishment of the operation depends much on the simultaneous movements of the whole three.

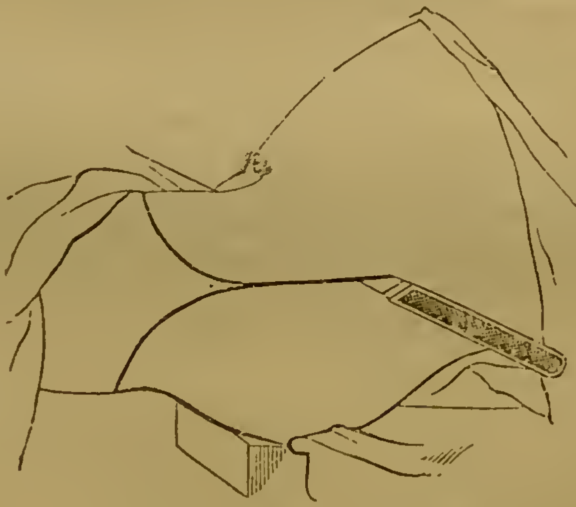

Fig. 98.

"The surgeon, standing on the outside of the limb, should insert the point of a long knife about midway between the anterior-superior spinous process of the ilium and trochanter major, keeping it rather nearer the former than the latter; he should then run it across the front of the neck of the bone, and put it through the skin on the opposite side (fig. 98), about 2 or 3 inches from the anus; next he should cut downwards and forwards, so as to make a long flap from the anterior of the thigh, about 7 or 8 inches in length. When the blade is entered, the limb should be held up, and even slightly bent at the joint; the instrument will then pass along more readily than if all the textures were thrown on the stretch; moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of the fibres, if not the whole of the iliacus internus and psoas muscles. As the knife is carried downwards, the assistant, who stands nearer the patient's trunk than does the operator, should slip his fingers into the wound and carry them across to grasp the femoral artery between them and the thumb; this he may do from the inside or outside at will, and with the right or left hand, as may be most convenient, the same grasp enabling him to raise the flap as soon as it is completed. The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any textures in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start out of its socket, and if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forward to allow the knife to be slipped over and behind it; and when it is in this position, it should then be carried downwards and backwards, so as to form a flap shorter than that in front, the last cut in the skin completing the separation of the limb."

Mr. Ferneaux Jordan first divides the soft parts circularly low down in the thigh, and then dissects out the bone from among the muscles and from the acetabulum through a long incision on the outer aspect of the limb, when the soft parts are comparatively thin and the blood-vessels inconsiderable, a long boneless stump being the result. Sir Jos. Lister writes:—* "It does not seem to me necessary to push it to the extreme degree advocated by Mr. Jordan, I would advise the following as the method to be generally adopted:—

"'Supposing the right limb operated upon, the knife is entered at the posterior part of the great trochanter and carried down longitudinally for about eight inches (if the patient be an adult male), and then drawn across the limb in front and behind through the skin and fat, in the form of two crescentic incisions, which meet at the inner side of the limb at a point an inch or two lower down than the extremity of the outer longitudinal cut. The semi-lunar flaps mapped out by the crescentic incisions are then dissected up as in a modified circular operation, the integument being raised about 2 inches higher than their angle of union at the inner side of the thigh, after which the muscles are divided when they are exposed and the head of the bone dissected out; or the femur may be sawn off below the trochanters, and then the head seized with strong forceps and dissected out.'"

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* Holmes' *System of Surgery*, vol. iii.

"Such a mode of operating, besides the diminished danger from shock, has the great advantage of making truly aseptic treatment easy, instead of almost impossible, as it is when the copious sero-sanguineous discharge, which takes place from so large a wound, is poured out within a very few inches of the anus, which is the case after the ordinary operation. After the operation which I have advised, the inner end of the wound having been closely stitched, and drainage tubes introduced at its outer part, there is sufficient space for an effective antiseptic dressing, and which will often be a matter of life and death where so large an extent of irritable and absorbent surface is concerned."

This operation or some form of it will probably commend itself to army surgeons as a simple method of amputating in such severe gun-shot injuries as may lead them to consider disarticulation requisite.

Mr. Davy has suggested a very ingenious mode of compressing the common iliac artery, by introducing into the rectum one end of a smooth wooden cylinder 2 feet in length and about 1 inch in diameter, passed in sufficiently far to permit it to be pressed down upon the vessel on the brim of the true pelvis, when the other end or handle of the instrument is carried to the thigh of the opposite side, and then raised so that the rod may act as a lever for which the anus serves as a fulcrum. In most cases in which Davy's lever has been employed, it has answered to admiration.

Amputation of the thigh may be performed by the circular method, by the lateral flap operation, by the antero-posterior flap operation, or flaps may be taken from any opposite aspects, or Teale's method may be adopted.

The operation may be performed immediately above the knee, in the middle of the limb, or in its upper third. In the middle and upper thirds of the thigh, the antero-posterior flaps leave the best results, and give the best covering to the bone; but amputation above the knee is best done by lateral flaps, which, however, are difficult to retain in position, and therefore if the patient is certain to have frequent moves, the surgeon might think the antero-posterior preferable.

Antero-posterior Flap Operation.—"In ordinary cases the anterior flap may first be made, and posterior one subsequently fashioned by transfixion. If, however, the patient is very much emaciated, it is difficult to get a good cushion from the anterior part of the thigh in this way; and it is consequently preferable to follow the plan recommended by Mr. Luke, of making the posterior flap first by transfixion, and the anterior one afterwards by cutting from without inwards. In some instances in which the tissues at the posterior part of the thigh are much diseased or injured, whilst those on the anterior aspect of the limb are sound, a very good stump may be fashioned by cutting a long square anterior flap by transfixion, and then cutting at one stroke of the knife through the soft parts at the posterior aspect of the limb, in a somewhat oblique direction, from below upward."

"If the patient be excessively muscular, and the amputation be a primary one, it is better to make skin-flaps with a circular incision through the subjacent soft parts."*

Amputation through the knee-joint may be performed with a long posterior and short anterior, or with a long anterior and short posterior flap. The former method, however, should only be chosen when the long anterior flap is impossible.

The operation by means of a long anterior and a short posterior flap is thus performed:—"A long square flap, rounded at the corners, is made by dissecting up the integuments and the patella from the front of the joint. The articulation is thus opened; the ligaments are then divided, and a short posterior flap formed by cutting from within outwards.

"The management of the patella is an important question. Erichsen thinks it is decidedly better to leave than to remove this bone; and to prevent it being drawn up on the anterior part of the thigh, the flap should be turned up, and the tendinous insertion of the quadriceps divided. The cartilaginous surface of the femur in these amputations may be sawn off if it is unhealthy."

Carden's Amputation at the Condyles of the Femur.—"The operator standing on the right side of the limb, seizes it between his left forefinger and thumb at the spot selected for the base of the flap, and enters the point of the knife close to his finger, bringing it round through the skin and fat below the patella to the spot pressed by his thumb; then turning the edge downwards at a right angle with the line of the limb, he passes it through the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upwards, and the saw is applied."

Fig 99 represents the outline of the incision, and fig. 100 the stump.

Mr. Carden lays great stress on the following points:—"Whilst tying the popliteal artery in this situation, there is a tendency to secondary hæmorrhage from the vein, in consequence of its close proximity to the artery. This occurred in two cases, and on re-opening of the stumps the closure of the vein was found to be prevented by the stroke of the artery. The vessels should be gently separated for an inch upwards. The

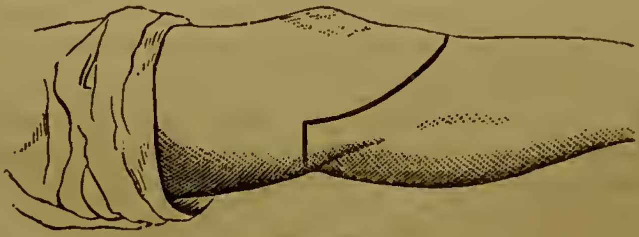

Fig. 99.

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* *Science and Art of Surgery*, by Erichsen, vol. i., p. 55.

dressing may be of the lightest and simplest kind, and it is of the greatest importance that they should be loosened and the stump examined early."

In performing this amputation, it should be remembered that nowhere does the skin retract so much as at the back of the knee-joint, and therefore full allowance must be made for it.

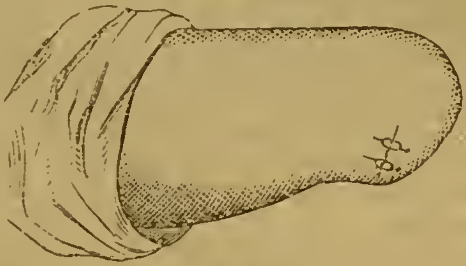

Fig. 100.

* "*Amputation of the leg* may be performed either just below the knee; in the middle or lower third. If the operation is too close to the knee, the stump is apt to become flexed, and so become an inconvenience; and if it is in the lower third the stump is too long for convenience. In the amputation below the knee-joint 4 inches of tibia should be left. Antero-posterior skin flaps of equal length may be made, and the bones divided somewhat higher up; or, again, the modified circular operation is applicable in this situation. But the former method by long anterior flaps is greatly to be preferred to any other on account of the excellent covering it affords, with the cicatrix out of the way of pressure. In this operation the posterior flap, being short, may be made of integument only without any risk of sloughing; on the other hand, the anterior flap being somewhat lengthy, should be raised so as to contain a good deal of muscle. A difficulty in retracting the soft parts from the bones arises from the intimate attachment of the muscles to the fibula, but if these are divided through an extension upward of the outer longitudinal incision, no difficulty is experienced, unless the tissues are condensed by inflammatory thickening, in effecting retraction of the remaining soft parts from the tibia.

"Again, the anterior tibial artery, on which the flap depends for its nutrition, lies close to the interosseous membrane, and would be very liable to be punctured during the dissection if we did not follow Mr. Teale's advice in conducting it. He pointed out that, in consequence of the looseness of the cellular connections of the interosseous membrane, there is no difficulty in separating the parts in front from its surface with the finger tip, while dividing with the knife the attachments of the muscles to the bones. In this way the artery is secured from any chance of injury.

"Immediately above the ankle the operation is performed as follows:—The diameter of the limb having been ascertained by spanning it, a straight longitudinal incision of that length is made at the inner side of the leg, and on the outer aspect another similar incision directly over the fibula and extending an inch higher up. The lower ends of these incisions are connected by cutting across the front of the limb in a direction transverse in the main but rounded off where it joins the lateral lines. The knife is next carried round the back of the limb to the bones from the upper ends of the internal incision to a point exactly opposite to the outer side, which will be about an inch below the upper end of the outer incision, the instrument being carried in a line slightly convex downwards, so as to form a very short posterior flap. The anterior flap is then raised in the manner above mentioned, including everything in front of the bones and interosseous membrane, after which the tibia and fibula are cleared as high as the level of the upper end of the outer incision, the finger tip being still used in detecting the parts anterior to the interosseous membrane. In order to avoid splintering the fibula it is best to saw both bones at the same time, and to finish the fibula before the tibia. The sharp angle of the spine of the tibia should be removed.

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* Holmes' *System of Surgery*, vol. iii.

"In amputating through the calf on the same principle, the operation is similar, except that owing to the redundancy of muscle in the posterior flap in a largely developed calf, when the posterior flap is apt to drag down the skin of the front of the leg on the sharp edge of the tibia and induce ulceration, the anterior flap need not be longer than two-thirds of the diameter of the limb; but to compensate for its diminution the posterior flap must be made at least half as long as the anterior by carrying the knife round the back of the limb at an angle of forty-five degrees through the integuments, and dissecting them up to the level of the upper end of the inner part of the incision before cutting towards the bones, so as to get rid of the heavy and contractile mass of the sural muscle.

"When there is not enough sound integument to admit of the long anterior flap, the modified circular of Mr. Syme proves highly valuable.

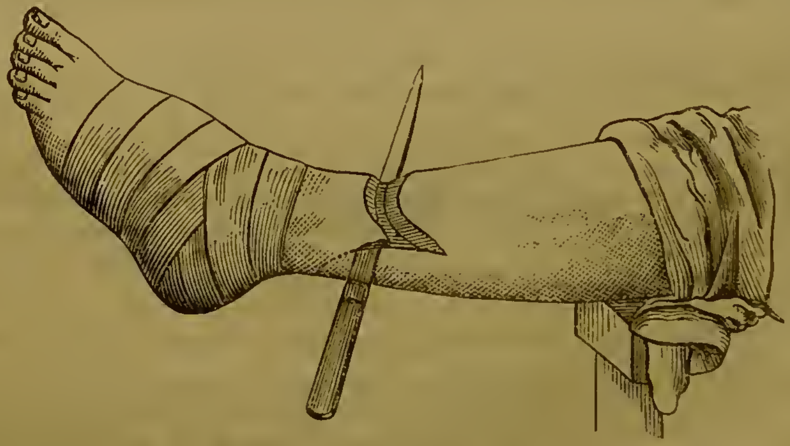

Fig. 101.

It is done thus. The skin and fat are divided by two crescentic incisions with the convexity downwards so as to form short antero-posterior flaps of the integument, which is then dissected up considerably higher than their angle of union, after which the operation is completed as in the ordinary circular method."—*Lister*.

Disarticulation of the Foot at the Ankle-joint (*Syme's Amputation*).—The foot being held at a right angle to the leg, the point of the knife is introduced immediately below the malleolar projection of the fibula, rather nearer its posterior than anterior edge, and then carried across the bone to the inner side of the ankle, where it terminates at the point *exactly opposite* its commencement. That will be below and behind the internal malleolus.

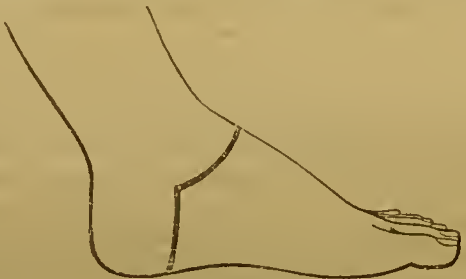

Fig. 102.

The extremities of the incision thus formed are then joined by another passing in front of the joint (fig. 102). The operator next proceeds to detach the flap from the bone, and for this purpose, having placed the fingers of his left hand over the prominence of the os calcis, and inserted the point of his thumb between the edges of the plantar incision, guides the knife between the bone and the nail of the thumb, taking great care to cut parallel with the bone, and to avoid scoring or laceration of the integuments. He then opens the joint in front, carries the knife outwards and downwards on each side of the astragalus, so as to divide the lateral ligaments, and thus completes the disarticulation. Lastly, the knife is carried round the extremities of the tibia and fibula, so as to afford room for applying the saw by means of which the articular projections are removed, together with a thin connecting slice of bone covered by cartilage. The vessels are then tied, and the edges of the wound stitched together.

Amputation through the Tarsus (*Chopart's Operation*).—" In the first place, the articulation of the cuboid with the os calcis (which lies about midway between the external malleolus and the tuberosity of the fifth metatarsal bone), and that of the navicular with the astragalus (which will be found just behind the prominence of the navicular bone in front of the inner ankle), must be sought for, and a semi-lunar incision be made, across the dorsum, from one to the other. The flap of the skin being turned, the internal and dorsal ligaments that connect the navicular to the astragalus are to be divided with the point of the bistoury, recollecting the convex shape of the head of the latter bone. The ligaments connecting the os calcis and cuboid are next divided; and, lastly, a flap is to be procured from the sole of the foot."

Amputation of all the Metatarsal Bones (*Hey's Operation, as described by himself*).—"I made a mark across the upper part of the foot, to point out as exactly as I could the place where the metatarsal bones were joined to those of the tarsus. About half an inch from this mark, nearer the toes, I made a transverse incision through the integuments and muscles covering the metatarsal bones. From each extremity of this wound I made an incision (along the inner and outer side of the foot) to the toes. I removed all the toes at their junction with the metatarsal bones, and then separated the integuments and muscles forming the sole of the foot from the inferior part of the metatarsal bones, keeping the edge of my scalpel as near the bones as I could, that I might both expedite the operation and preserve as much muscular flesh in the flap as possible. I then separated with the scalpel the four smaller metatarsal bones at their junction with the tarsus, which was easily effected, as the joints lie in a straight line across the foot. The projecting part of the first cuneiform bone which supports the great toe I was obliged to divide with a saw."

To avoid the difficulties of disarticulation, Skey recommends cutting off the head of the second metatarsal with a pair of pliers. Baudens, Guérin, and others, approve of sawing all the bones across in the line desired.*

Removal of Metatarsal Bone of Great Toe.—"The point of a strong and broad bistoury should be entered on the dorsum of the foot over the interspace between the first and second metatarsal bones, as far back as possible; it should then be carried forwards upon the ball of the great toe, to a point opposite to the web between the toes, and thence made to sink into the sole of the foot in a line parallel with the outer margin of the bone; the flap thus formed should be dissected back, its plantar aspect being kept as thick and fleshy as possible. The surgeon next passes the knife between the first and second metatarsal bones, and cuts directly forwards through the centre of the angle between the great and the second toes. In doing this, care must be taken that the edge of the knife is not directed too much towards the metatarsal bone of the great toe, lest it hitch against one of the sesamoid bones. The surgeon next seizes the extremity of the toe, and pressing it well inwards, passes the point of the bistoury deeply into the angle of the wound, where, by the division of some tendinous and ligamentous fibres that constitute the key of the joint, he opens the articulation, and detaches the bone by lightly touching its ligamentous attachments.

"When the bone is to be partially removed, the operation must be performed in the same way; the incisions, however, not being carried so far backwards." †

Removal of Metatarsal Bone of Little Toe.—"This is best done by entering the point of the knife just behind the tubercle of the bone, carrying it forwards and inwards in the line of its articulation, with the cuboid, to the centre of the fourth digital interspace, and thence forwards to the web of the toe; the knife is next carried round the plantar surface of this, the incision being continued obliquely into that which has been made on the dorsum of the foot. The small flap thus formed is well dissected down, the knife passed round the under surface of the bone, and the joint opened by the toe being forcibly drawn outwards, and its ligamentous connection lightly divided."*

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* Bell's *Manual of Operative Surgery*, p. 76.

† Erichsen's *Science and Art of Surgery*, vol. i., p. 45.

Amputation of Distal Phalanx of Great Toe.—When possible, a long flap should be made from the plantar surface, by laying the edge of the knife over the dorsal aspect of the joint, cutting through it, and turning the edge of the knife round close to the bone, so as to cut out a long flap from the ball of the toe.

Amputation of a single lesser Toe: Second, Third, or Fourth.—"This operation is exactly on the same principle as that described for amputation of a whole finger, but it should be remembered that the metatarso-phalangeal joint is more deeply situated in the soft parts than is the metacarpo-phalangeal; and thus the commencement of the elliptical incision which is to surround the base of the toe must be proportionally higher up. On the other hand, as it is very important to avoid as much as possible any cicatrix in the sole of the foot, the plantar end of the incision need not be carried to a point exactly opposite the one from which it set out, but it will be sufficient if it reaches the groove between the toe and sole."

Teale's Operation (Amputation).—This plan of operation Mr. Teale introduced "to procure a more useful stump, and in the hope of somewhat diminishing the mortality of the operation. It is proposed to amputate by a long and a short rectangular flap, the long flap folding over the end of the bone being formed of parts generally devoid of large blood-vessels and nerves, whilst those important structures are contained in the short flap. The size of the long flap is determined by the circumference of the limb at the place of amputation, its length and its breadth being each equal to half the circumference. The long flap is therefore a perfect square (fig. 103), and is long enough to fall easily over the end of the bone. In selecting the structures for its formation, such parts must

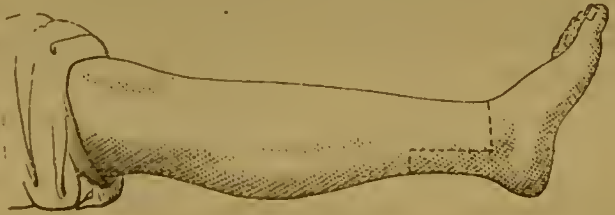

Fig. 103.

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* *Ibid*, p. 48.

be taken as do not contain the larger blood-vessels and nerves. A flap so formed will be for the most part anterior in position as far as regards the general aspect of the body, but superior when the patient is in the recumbent position, as during the after-treatment. The short flap, containing the chief vessels and nerves, is in length one-third of the other. The flaps being formed, the bone sawn, and arteries tied, the long flap is folded over the end of the bone; each of its free angles is then fixed by sutures to the corresponding free angle of the short flap. One or two more sutures complete the transverse line of union of the flaps. At each side the short flap is united to the corresponding portion of the long one by a point of suture, and one suture more unites the reflected portion of the long flap to its unreflected portion. Thus, the transverse line of union is bounded at each end by a short lateral line at right angles to it" (fig. 104).

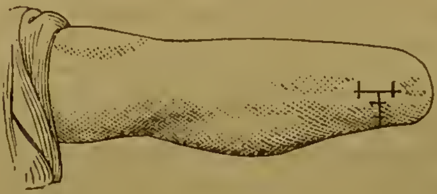

Fig. 104.

Lister thinks this operation should be restricted to the lower part of the leg and just above the knee, when by turning to account the integument over the patelle, which is not used in ordinary operations, the anterior flap may be made of the requisite length without specially high division of the bone.

Pirogoff's Amputation.—"The operation is performed in the following way:—An incision is carried across the sole of the foot from the tip of the external malleolus to the corresponding point on the other side, that will be half an inch below and behind the internal malleolus.

"This incision must not be made directly transverse to the foot, but should incline forwards obliquely, so that the centre of the incision in the sole may be at least an inch in front of a line drawn across from the tip of one malleolus to the other. The flap thus traced is dissected for about two lines. Disarticulation of the astragalus is then effected in the usual way by an incision across the front of the foot.

"The foot is now forcibly extended to the greatest possible extent, and a narrow amputating or a butcher's saw is applied to the upper and back part of the os calcis behind the astragalus, and the bone is cut obliquely downwards and well forwards; the malleoli are then removed, and a thin slice of the tibia, with the articular cartilage, taken off. The opposed osseous surfaces must then be accurately adjusted, the movable flap well supported by a broad strip of plaster, and the limb laid on the outer side, with the knee placed so as to take off the tension of the tendo-Achillis."

The advantages of the long oblique section of the os calcis over the shorter almost vertical cut originally made by Pirogoff, are, as Busk has pointed out, that a larger surface of bone is brought into contact with the sawn ends of the bones of the leg, there is less tilting of the os calcis, and that the thick skin of the heel serves as the basis of support instead of the thin skin of the back of the heel.

Sub-periosteal Amputation.—To prevent attenuation of the end of the bone or necrosis, Langenbeck has proposed that its divided surface should be covered with a long flap of periosteum formed in the course of the amputation. Dr. R. Schneider holds that Langenbeck's proceeding does not always lead to such good results, and that the single flap of periosteum may slough. He recommends two short flaps of periosteum, each flap being carefully retained in connection with the superjacent muscular and other soft parts.

EXCISION.

Cheyne remarks:—* "Excision of joints is now rarely performed, for with aseptic treatment an incision into a joint and the insertion of a drainage tube is generally sufficient in cases where formerly excision, or even amputation, would have been required."

Excision of the Head of the Humerus.—This operation may be performed in several different ways; they consist of a single vertical incision, and its modifications of Γ and T shaped ones; also the flap operation of U shape. Larrey recommended the single long incision, extending in a line from the acromion, through the fibres of the deltoid, for about 4 or 5 inches. This operation is thus described:—"The patient lies on the side opposite to the affected or injured limb. The surgeon then enters the knife a little to the outside of the coracoid process, and carries it downwards and outwards for about 5 inches, cutting down to the bone. He then cuts across the capsule any adhesions that may exist, and the attachments of the muscles inserted into the tubercles of the humerus. The assistant, who has charge of the limb, facilitates this part of the operation by drawing it well across the chest, and pushing the head of the bone backwards and tilting it outwards, so as to cause it to project. The surgeon, carefully clearing it all round, has the soft parts well retracted, and then, taking the limb in his own hands, pushes the head of the bone out of the wound. so as to admit of the easy application of the saw by which it is removed."

Mr. Hamilton remarks on this subject:—"In gun-shot or other comminuted fractures of the head of the humerus, demanding ex-section, the surgeon will find it necessary, in general, to make for himself a larger opening than the single longitudinal incision will furnish. It will be necessary, then, to make an oval or V-shaped incision, so as to form a flap, having its base upwards."

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* In his work on *Antiseptic Surgery.*

Guthrie considers that in doing this operation, in cases of some standing, he prefers a short crescentic flap by an incision across the anterior part of the shoulder, as in the operation of amputation, which on being turned up leaves the joint exposed. The edge of the knife being applied to the head of the bone in a line below, but immediately under the acromion process, divides the capsular ligament, and with it the long tendon of the biceps, on which the arm drops from the socket or glenoid cavity, and allows the finger to be introduced, when the three muscles inserted into the great tuberosity may be cut through, and the subscapularies, inserted into the small tuberosity, will also be divided.

Sir William Fergusson is of opinion that the surgeon should not limit himself to one mode of procedure, but should rather, trusting to his anatomical and manipulative skill, adapt his measures to the peculiarities of the case. He recommends the adoption of a plan similar to that originally followed by Morel. The patient being seated or laid on his back, an incision should be made with a strong bistoury, commencing opposite the coracoid process, and ending about an inch behind and below the root of the acromion. It should be semi-lunar in shape. The extreme convexity should be about 4 inches under the acromion, and thus the greater portion of the deltoid will be included in this flap. The skin and deltoid being divided, the flap should be drawn upwards, a few touches of the knife being sufficient to separate the loose connections of this muscle. A bold incision should next be made through the tendons attached to the tuberosities of the humerus, dividing them and the capsule at the same time to such an extent as to permit the head of the bone being turned out by a slight twist. This part should then be laid hold of with the lion forceps by the surgeon or an assistant, and held steady whilst the saw is used to separate as much as may be necessary. If the operation is done for a shattered bone, its head cannot be thrust out like the end of a lever, as thus directed; and therefore the surgeon must make use of his fingers or any convenient hook or forceps to enable him to raise the fragments.

Much of the success in rendering a limb useful after excision of the head of the humerus depends upon early passive movements, followed up by regular exercises with weight and pulley.

Excision of the Clavicle.—It may be necessary to remove this bone wholly or partially, and to perform the operation it is necessary to make a free incision along its whole length; it should then be disarticulated or sawn through at its acromial articulation, and dissected out from without inwards, the sternal end being forcibly twisted outwards, and all attachments carefully cut, great care being paid to the numerous small veins in this position.

Excision of the Scapula (Syme's Operation).—Make an incision from the acromion process transversely to the posterior edge of the scapula, and another from the centre of this one directly downwards to the lower angle of the bone. The flaps formed being reflected back, separate the scapular attachment of the deltoid, and divide the connections of the acromial extremity of the clavicle. The division of the subscapular artery will cause a great gush of blood, but it should be caught and secured without delay. The joint and around the glenoid cavity should next be cut into, and the finger hooked under the coracoid process, so as to facilitate the division of its muscular and ligamentous attachments; and then, by pulling back the bone with great force by the left hand, the remaining attachments should be divided with rapid sweeps of the knife.

Excision of the elbow-joint may be performed in three different ways—by a simple longitudinal incision, or by the H or ⊢. The longitudinal incision is by far the best. It will require a cut 4 inches in length having its centre opposite the tip of the olecranon. The triceps muscle will thus be divided into two portions, the inner one of which is the more firmly attached to the ulna, while the outer portion is continuous with the anconeus muscle, and sends some tendinous fibres to blend with the fascia of the forearm. The power of extension depends greatly upon these tendinous fibres, and every effort should be made to preserve them. Any transverse cut is therefore to be greatly deprecated. In carrying the incision in this direction, Erichsen recommends that "the edge of the knife should always be kept against the bones, and their sinuosities closely followed, so that the ulnar nerve, being dissected out from behind the inner condyle, may escape injury. If the incision be properly planned, and the knife kept in contact with the bone, the nerve ought not to be exposed during the operation, more particularly as it is usually imbedded in a quantity of plastic tissue. When the posterior part of the joint has been laid bare in this way, the knife should be carried round the tip of the olecranon, and the process removed with cutting pliers. By forcibly bending the joint, pushing the forearm upwards, and lightly touching the ligaments with the point of the knife, the interior of the articulation will be fully exposed. By means of a small narrow saw, the articular end of the humerus is separated from the rest of the bone; the upper end of the ulna and the head of the radius may either be removed in the same way or by cutting pliers."

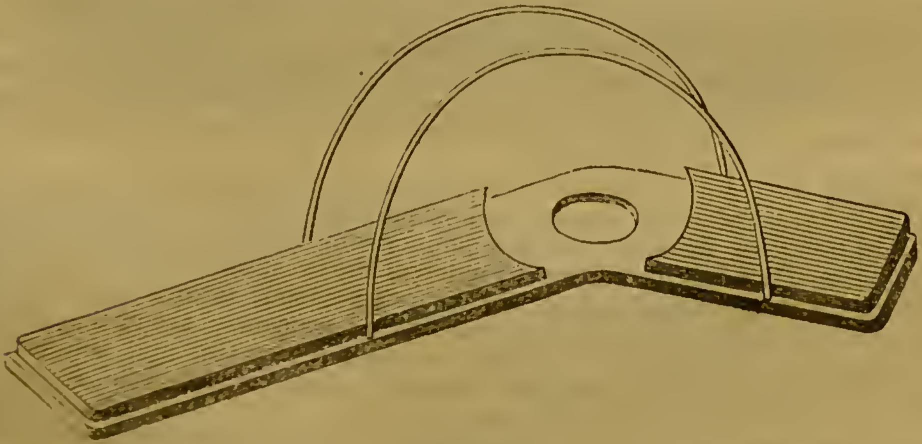

Fig. 105.

After the operation, the limb should be laid upon pillows nearly in the extended position; or Esmarch's splint may be applied (fig. 105).

This splint, which Dr. Stromeyer designed for the more convenient treatment of excision or resection of the elbow-joint was improved upon by Professor Esmarch; by means of it the arm can be raised up, without the joint being disturbed. It is made from two of Stromeyer's arm splints, of which the under is uncushioned, but the upper one stuffed with wadding and covered with oilcloth, and at the region of the elbow a wedge-shaped piece is sawn out (fig. 105). The upper arm-piece of this splint is retained in position with the forearm piece by means of two hoops of strong wire. The arm rests on this splint, which can be raised by means of the wire, while the bandages and dressings are quickly removed from the lower splint, and which after it has been cleaned and the wound dressed can be replaced.

Numerous contrivances have been invented for placing the elbow on after resection, but an ordinary soft pillow answers all purposes, on which the limb should rest in nearly the extended position, so that the cut portions of the bones may be in close approximation with one another.

"At the end of a week or ten days, when granulations have sprung up, the arm may be put on a slightly bent leather splint, and as the healing goes on this may gradually be flexed, until at last it is brought to a right angle.

"Until the contraction of the cicatrix has fully taken place, and the neighbouring tissues are quite firm, the joint should be supported by one lateral leather splint on the inner side of the arm. The splint should then be removed, the arm put in a sling, and passive motion had recourse to, in order to prevent osseous anchylosis."

Ingenious splints have been designed by Drs. Hodgen and Volkman, Messrs. Butcher and Heath, but an ordinary firm pillow will be found to answer all purposes, care being taken to commence passive motions early, and exercises with weight and pulley as soon as the inflammation consequent on the operation has subsided.

Excision of the Wrist.—This operation is not in much favour with military surgeons. It may, however, be performed in several different ways. In disease, the presence of sinuses on the surface may be taken advantage of and followed up, giving sufficient opening between the extensor tendons and the bones.

Sir J. Lister has adopted a method for excision of the wrist which has given satisfactory results, and which Mr. T. Holmes describes as follows:—"An incision is made commencing in front over the second metacarpal bone, internal to the tendon of the extensor secundi internodii pollicis, and running along the back of the carpus internal to the same tendon, as high as to the base of the styloid process of the radius. The soft parts, including the extensor secundi internodii, and the radial artery, being cautiously detached from the bones external to this incision, and the tendons of the radial extensors of the wrist being also severed from their attachments, the external bones of the carpus will be exposed. When this has been done sufficiently, the next step is to sever the trapezium from the other bones with cutting pliers, in order to facilitate the removal of the latter, which should be done as freely as is found convenient. The operator now turns to the ulnar side of the incision, and cleans the carpal and metacarpal bones as much as can be done easily. The ulnar incision is now made. It should be very free, extending from about 2 inches above the styloid process down to the middle of the fifth metacarpal bone, and lying near the anterior edge of the ulna. The dorsal line of this incision is then raised, along with the tendon of the extensor carpi ulnaris, which should not be isolated from the skin, and should be cut as near its insertion as possible. Then the common extensor tendons should be raised, and the whole of the posterior aspect of the carpus denuded, until the two wounds communicate quite freely together; but the radius is not as yet cleaned. The next step is to clean the interior aspect of the ulna and carpus, in doing which the pisiform bone and the hooked process of the unciform are severed from the rest of the carpus, the former with the knife, the latter with the cutting pliers. In cleaning the anterior aspect of the carpus, care must be taken not to go so far forwards as to endanger the deep palmar arch. Now, the ligaments of the internal carpal bones being sufficiently divided, they are to be removed with blunt bone forceps. Next, the end of the ulna is made to protrude from the incision, and is sawn off, as low down as is consistent with its condition, but in any case above its radial articulation. The end of the radius is then cleaned sufficiently to allow of its being protruded and removed. If this can be done without disturbing the tendons from their grooves it is far better. The operator next attends to the metacarpal bones, which are pushed out from one or other incision and cut off with the pliers so as to remove the whole of their cartilage-covered portions. The trapezium bone, which was left in the early stage of the operations, is now carefully dissected out, so as to avoid any injury to the tendon of the flexor carpi radialis or to the radial artery, and the articular surface of the first metacarpal bone is then exposed and removed. Lastly, the cartilaginous portion of the pisiform bone is taken away; but the non-articular part is left behind unless it is diseased, in which case it should be removed entire. The same remark applies to the hooked process of the unciform.

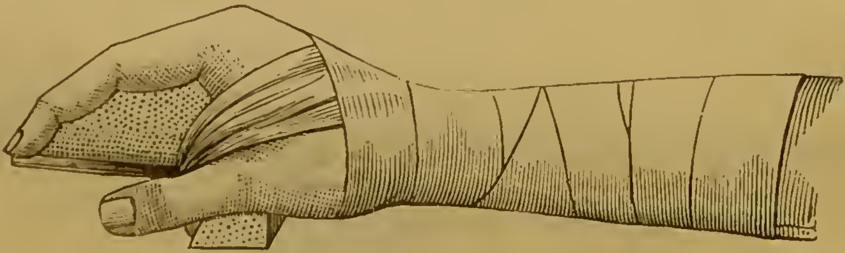

Fig. 106.

"In order to ensure motion, particularly in the fingers, passive movements should be performed from a very early period after the operation.

For this purpose, Lister places the limb on a splint with the palm of the hand raised by a large wedge of cork fixed below it, so that the joints of the fingers can be moved without taking the limb off the apparatus" (fig. 106).

MacCormac reports most favourably on an apparatus of Professor Esmarch for treating cases of resection of wrist-joint. "The hand and arm are placed in a prone or semi-prone position on the splint (fig. 107), whose form is such as to leave the wrist exposed and easy to be got at for the application of dressings. The whole apparatus *en fonction*, consisting of a suspending rod, a plaster of Paris or other form of bandage, and the splint, is represented in fig. 108, and the facility with which the patient can move about in bed, or readjust the position of his arm, is at once perceived."

Excision of the Carpal Ends of the Bones of the Forearm.—Mr. Skey recommends the following operation:—"The joint is exposed on the dorsal surface by two lateral incisions of 2 inches in length, united by a transverse line made below the projecting bone. The flaps being raised, the tendons are exposed, and should be separated from the radius by a knife passed underneath them in forcible extension of the hand backwards. Along this line the fine blade of a metacarpal saw may be readily passed, which, being jointed at the point, can be fixed to its back after passing across the tendon. The blade of a knife passed half an inch under the radial artery will protect it from injury."

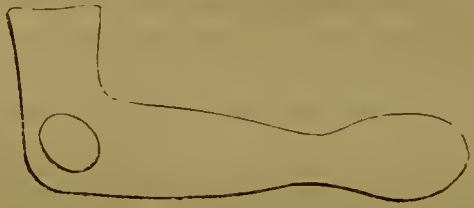

Fig. 107.

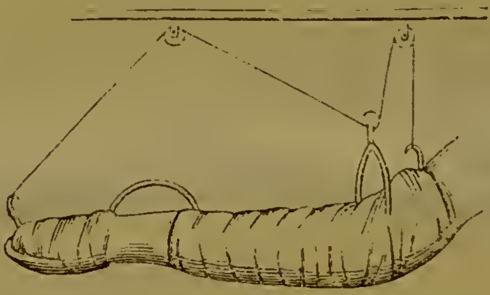

Fig. 108.

Excision of the Hip-Joint.—This operation may be performed by incisions of such shapes as may suit the surgeon's convenience for removal of the damaged bone; and in the event of the injury being from a gunshot, there will be an open wound which may be extended. There are, however, certain methods laid down by different authorities. Professor Gross prefers a semi-lunar flap of the gluteal muscles with the convexity downwards. This plan of incision, he considers, has the advantage, not only of allowing free access to the joint, but also of affording a ready outlet for the discharges. The superior extremity of the femur being thus exposed, is thrust out of the opening by carrying the limb across the sound one, rotating it inwards, and then pushing it up, when it is to be divided by means of a narrow saw. The great trochanter, however sound, should always be included in the operation, otherwise it will be sure to interfere more or less seriously with the healing process by projecting into the wound.

Sir William Fergusson remarks on this operation: "Like resection of the head of the humerus, many different methods of exposing the upper end of the femur have been recommended." He holds the opinion that a knowledge of anatomy will best enable the surgeon to suit the proceeding to the peculiar features of each case. It would be folly to make a larger wound than is required for the due performance of the operation; and as long as the operator limits himself—in front, so as not to meddle with the branches of the crural nerve, or endanger the femoral arteries; and behind, so as to protect the sacro-sciatic nerve—it seems to him of little consequence what lines are cut on the surface. A straight one will, he believes, answer in general, but, with the views inculcated, it matters not what shape the flaps may be.

Many splints have been designed for the after-treatment of excision of the head of the femur. For permanent hospitals, Mr. Sayer's splint (wire breeches*) is perhaps the best; but for field hospitals, where appliances may have to be extemporised, a long splint as shown in fig. 109, which is similar to Erichsen's appliance, seems well adapted, and can be easily made. To secure rest, a certain amount of extending force, and the straightening of the limb, should be the surgeon's aim.

In treating a case of excision of the head of the femur at Netley, I† adopted the stretcher and bed as represented in figs. 110, 111, which answered to my entire satisfaction.

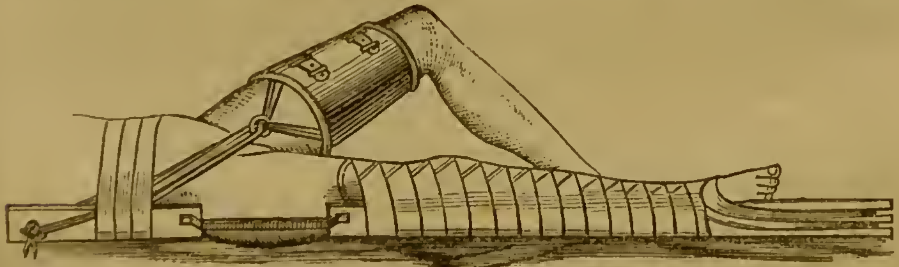

Fig. 109.

The stretcher (fig. 110) consists of a substantial beech or ash frame with handles, and of such a size that, when placed on the mattress, the woodwork falls over its sides, and does not come in the way of the patient's arms or the hands of the attendants.

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* *British Medical Journal*, July, 1871.

† Porter.

The canvas bottom is divided into five portions; the three centre are 6 or 8 inches wide; these are attached to the framework on one side by means of straps and studs, and on the other by straps and buckles, by which they may be pulled tight. They are removable at will, and enable the surgeon or attendant to dress the wound when the stretcher has been raised. The canvas at the top and bottom of the stretcher may be secured by cords, or straps and buckles, so as to admit of being removed for cleaning. Two movable tressels have to be made for the stretcher to be placed upon when necessary.

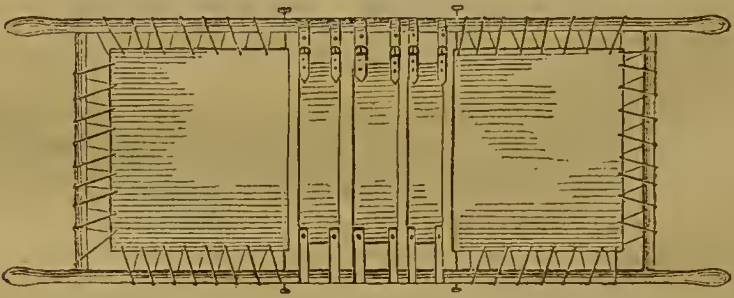

Fig. 110

The advantages which this stretcher possesses are that, from the moment the patient is placed on it, he need not be disturbed, as by simply raising it, placing it on the tressels, and removing one of the strips of canvas, the wounds may be dressed and excreta removed. The patient may be carried from one room to another, or into the open air, without the least disturbance; and, in the event of there being a bedsore, the stretcher may be placed on tressels for a short time, and the parts relieved from pressure.

The bed speaks for itself, as represented in fig. 111, the chief features in it being the firm foundation for the mattresses by having the bedstead boarded. The top mattress is divided into three portions, the centre one of which has a round hole 10 inches in diameter in its centre, into which the patient's nates fit. This centre piece may be removed to facilitate dressing, as represented in the illustration.

Fig. 112 represents a crossbar arranged with straps and buckles at each end, intended to be inserted between the sides of the stretcher, so as to prevent their bowing inwards when the straps attached to the canvas are pulled tight. It may be brought into use by gently moving the head portion of the top mattress, so as to allow of its being inserted underneath the stretcher.

Sir W. Fergusson recommends that the extension should be made from the opposite thigh (fig. 109), round the upper part of which a socket is fixed, to which the band is attached. The splint being bracketed, dressings can be applied with ease, and extension made by means of a weight.

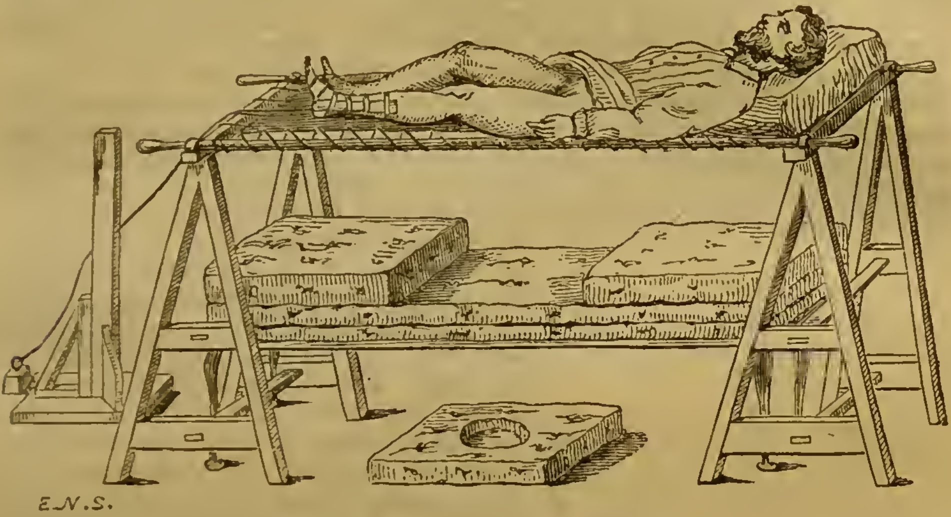

Fig. 111.

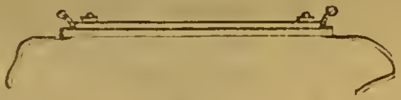

Fig. 112.

Excision of the Knee.—In excising the knee-joint for gun-shot injuries, the army surgeon may be able to take advantage of a wound already existing in forming his incisions, instead of adhering to any plan of incision as laid down in civil practice. He has, however, many plans to select from—such as the straight transverse incision; two parallel incisions, one on each side of the patella; an H-shaped incision; a horse-shoe incision; or, as Mr. P. Watson recommends, "a semi-lunar incision, raising a long flap from the anterior surface of the articulation."

But the operation is never likely to find favour in the field. Injuries to the joint that would lead to such an operation would be much better met by amputation above the knee, which would probably enable the patient to be carried with due regard to his safety, whereas, after excision, rest is absolutely necessary, and if this could not be ensured the operation in all probability would only have a fatal result.

Excision of the Ankle.—For removal of the entire joint Mr. Handcock devised the following method:—"The foot is first laid on its side, and an incision is made over the lower 3 inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus, it forms an angle, and runs downwards and forwards to within about half an inch of the base of the outer metatarsal bone. The angular flap is reflected forwards; the fibula, about 2 inches above the malleolus, is sufficiently cleared of soft parts to allow cutting forceps to be placed over it; and the bone is then nipped in two and carefully dissected out, leaving the peroneus longus and brevis tendon uncut. The foot is now to be turned over. A similar incision is made on the inner side, the portion on the foot terminating over the projection of the inner cuneiform bone. The flap is to be turned back, and the sheaths of the flexor digitorum and posterior tibial tendons exposed, the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament is then to be severed carefully close to the bone; and now the foot is twisted outwards, and the astragalus and tibia will present at the inner wound. A narrow-bladed saw, put in between the tendons into the inner wound, projects through the outer. The lower end of the tibia, then the top of astragalus, may be sawn off in a proper direction. The only vessel that may require tying is one of the lower branches of the peroneal artery. The wound may be closed with sutures, except that part opposite the breach of osseous matter; the leg and foot placed on a splint with footboard, and cold water applied."

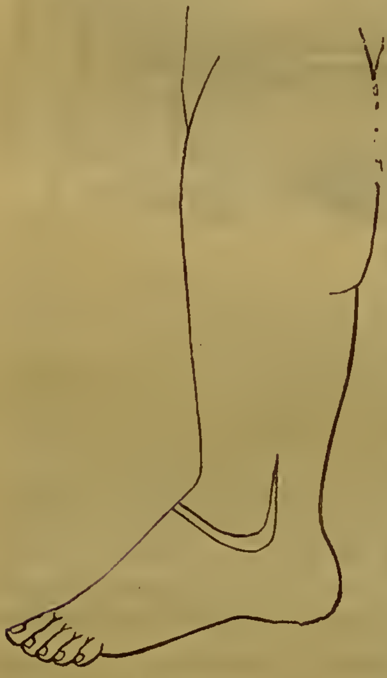

Fig. 113.

Guthrie recommends the following method for excision of the ankle:—"Begin the incision behind the external malleolus, an inch and a half above its lower extremity, and carry it downwards and then forwards across the front of the ankle-joint (fig. 113), then under the internal malleolus and upwards, close behind the process, the extent of an inch and a half; this incision should merely divide the skin, and should not, on any account, wound the subjacent parts. Raise the flap thus made, and, placing the leg on its inside, detach and turn aside the peronei tendons from the groove behind the external malleolus. Cut through the external lateral ligaments of the ankle-joint, keeping the knife close to the end of the fibula; then with the large bone scissors, or nippers, cut through the fibula from one-half to three-quarters of an inch above its junction with the tibia, and, after dividing the ligamentous fibres connecting the two bones, remove the malleolus externus. Turn the leg on to its outer side, and cut through the internal lateral ligament close to the tibia, to avoid wounding the posterior tibial artery; this will allow the foot to be dislocated outwards, and the lower end of the tibia to be brought well out through the wound. An assistant keeping the foot and tendons out of the way, the lower end of the tibia is to be removed with a fine saw to the same extent as the fibula, or as high as the injury or disease requires. The articulating surface, or injured part of the astragalus, is then to be removed, after which the foot is to be returned to its proper position, and the cut surfaces of the tibia and astragalus brought into close approximation, and so kept by suture, strapping, and bandage. The limb is to be placed on an outside leg-splint, having a foot-piece to it."

Professor Esmarch has designed a splint for the after-treatment of excision or resection of the ankle-joint; he found the great utility of such an apparatus for resection of the elbow-joint, and in consequence applied it to the ankle.

It consists of a strong piece of iron wire placed in front of the limb, extending from the toes to the groin, and bent at convenient angles to suit the front of the ankle and the knee, taking care that an arch is formed with it immediately above the seat of operation. Hooks should be formed with the wire at either end, and two or three loose ones attached for the purpose of suspension (fig. 114). Underneath the limb should be placed a wooden splint, hollowed out and cut to an angle to correspond with

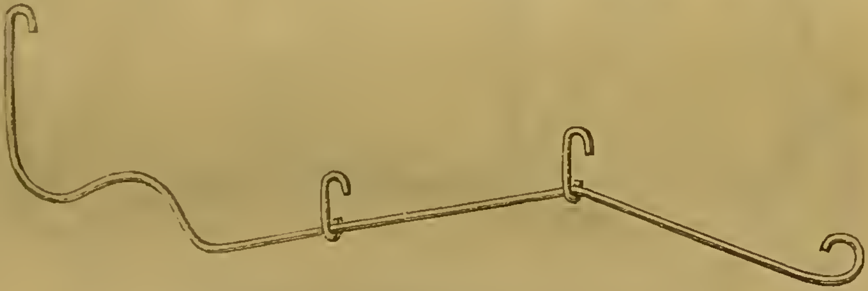

Fig. 114.

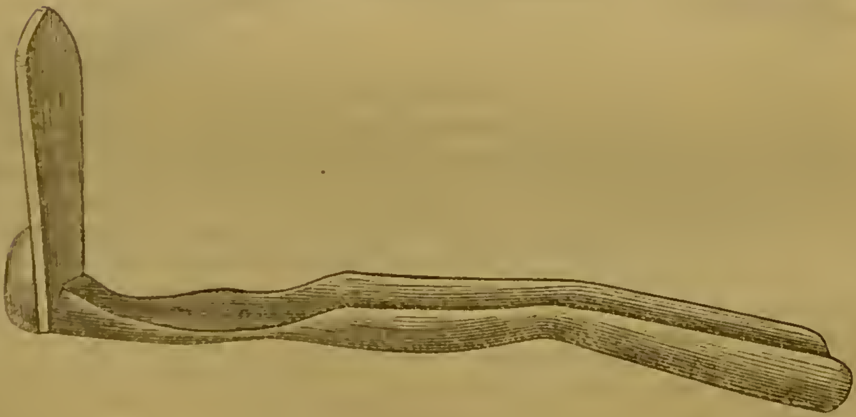

Fig. 115.

the bend of the knee. Firmly secured to this is a foot-board, placed at right angles, which gives support to the foot, and forms a base for the plaster of Paris bandage (fig. 115).

In using the apparatus, the wooden splint should be most carefully cushioned and applied, especially about the heel and foot, where any undue pressure may be attended by most serious consequences. The plaster of Paris bandage should then be applied in the usual manner, an opening being left at the seat of the wound for the purpose of applying dressings. Fig. 116 represents the splint applied and suspended.

Professor Esmarch says he has applied this apparatus in cases of resection of the ankle-joint for six or seven weeks, and that the patients have never once had to complain of aches or pains, and that the advantages of these suspension splints are so great that he recommends them most earnestly for war service, as well as in time of peace.

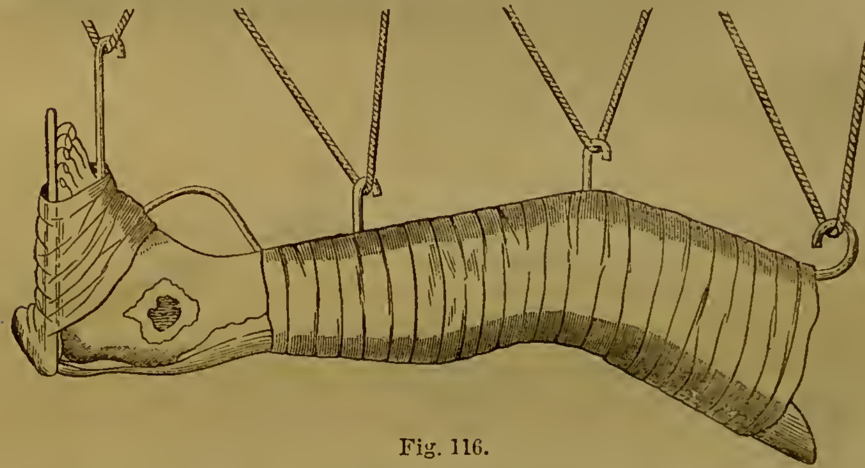

Fig. 116.

Excision of the Os Calcis.—"The patient lying on his face, a horseshoe incision is carried from a little in front of the calcaneo-cuboid articulation round the heel, along the side of the foot, to a corresponding point on the opposite side. The elliptic flap thus formed is dissected up, the knife being carried close to the bone, and the whole under-surface of the os calcis exposed. A perpendicular incision, about 2 inches in length, is then made behind the heel, through the tendo-Achillis, in the mid-line and into the horizontal one. The tendon is then detached from its insertion, and the two lateral flaps are dissected up, the knife being kept close to the bones, from which the soft parts are well cleared. The blade is then carried over the upper and posterior part of the os calcis, the articulation is opened, the interosseous ligaments are divided, and then, by a few touches with the point, the bone is detached from its connection with the cuboid. This bone, together with the astragalus, must then be examined; and if any disease be met with, the gouge should be applied."

Excision of the Astragalus.—"A curved incision should be made from one malleolus to the other, something like that made at the beginning of down by Mr. Guthrie; nevertheless, it may be departed from when the torn extremity of a large artery is seen or felt to pulsate, and its permanent closure by natural means appears doubtful. An artery which has recently ceased to bleed may also be cut down upon and tied in certain emergencies. Such practice may be judged to be right, when delirium tremens supervenes upon the injury, or when, as in some military movements, the wounded are ordered to be transported to another position. Mr. Holmes considers this rule may be departed from in cases in which the surgeon judges, by the severity of the previous bleeding, that a large vessel has been wounded that the hæmorrhage will probably recur, and when the patient must be left at a distance from competent aid.

A wounded artery when requiring a ligature should be tied in the place where it bleeds; nevertheless, since it is sometimes impracticable to tie the vessel in the wound, the trunk should then be secured at the next convenient place above the bleeding orifice. Mr. Guthrie inculcated this principle, and says:—"No operation is to be done for a wounded artery in the first instance, but on the spot injured, unless such operation not only appears to be, but is impracticable."

The greater number of competent authorities of the present day agree with Mr. Guthrie in his recommendation to cut down directly upon the wounded part of the injured artery, for the following reasons:—That the ligature of the main trunk at a distance above it would only stop the direct supply of blood to the limb; but it would not interfere with the anastomosing circulation, and blood would find its way to the distal aperture of the artery: that it may not be possible for the surgeon to ascertain the exact artery the bleeding is coming from unless he looks for it, and instances have been known where main trunks of arteries have been tied, and the hæmorrhage has been from some small vessel unconnected with it. Stromeyer is of opinion that the plan of tying a wounded artery at the spot often does very well in minor vessels, but it frequently fails in the femoral artery. The large vein accompanying the artery has often been torn or bruised by the same bullet. After tying the artery at the spot, the vein often becomes totally impervious, and the hæmorrhage recurs, or the limb becomes gangrenous. It may be proper, in some cases, to gain time by putting a ligature above the wounded spot; before new hæmorrhage occurs, the vein may have undergone a favourable change. In other cases it is better to amputate.

The external wound should be taken as the guide for the incision, and it is recommended that "in *cutting down on a wounded artery*, a large probe should be passed to the bottom of the wound, and taking this as a centre, a free incision should be made in such a direction as may best lay open the cavity with the least injury to the muscles and soft parts. After turning out any coagula contained in the wound, and clearing it out as well as possible, the injured vessel must be sought for." Great care should be observed in ligaturing the vessel in consequence of the altered condition of the structures, from inflammation or infiltration.

The operation may be greatly facilitated by the application of Esmarch's bandage. Should the wound in the vessel not be apparent, it is only necessary to loosen the bandage, when the jet of blood will declare its position. The artery, when found, should be tied or twisted both above and below the wound in it. The necessity for tying the lower end is the greater, because it is the more frequent source of secondary hæmorrhage.

When the lower end of the vessel cannot be found, a piece of compressed sponge, left in the wound, sometimes prevents subsequent hæmorrhage. It is not advisable to apply a single ligature immediately below the origin of a large branch.

Intermediary or reactionary hæmorrhage may occur some hours after the receipt of a wound, or as soon as the patient becomes warm, and reaction is completely established. If position, cold, and the compression of a bandage does not check it, the wound must be opened out and the bleeding vessel sought for and tied.

Secondary hæmorrhage is common in gun-shot wounds due to sloughing of the parts injured, or the reopening of a wound in which a vessel is temporarily closed. It may occur from the fifth to the twenty-fifth day after the infliction of an injury.

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It may be produced by local or constitutional causes, the former being any movement which may disturb the wound or increase the rapidity of the circulation: as, for instance (*a*) by transporting wounded men too soon, which may be unavoidable; (*b*) by the imperfect application of a ligature; (*c*) by sloughing or ulceration of a large vessel; (*d*) by projecting spicula of bone injuring a vessel; (*e*) by a peculiar *hæmorrhagic diathesis* natural to some persons, but which on service in the field generally presents itself when the men are scorbutic and worn out by fatigue and privation. The most common cause probably, is unhealthy septic inflammation and suppuration in the neighbourhood of the artery.* Under these influences its coats soften and yield in places to the blood pressure, when some spot may ultimately give way, and hæmorrhage be the result. If the ends of the arteries are imbedded in healthy granulation tissue, there will be no secondary hæmorrhage.

Treatment of Secondary Hæmorrhage after Gun-shot Wounds.—When severe the surgeon will have to cut down on the wounded artery and tie or twist both ends, or tie it in its continuity leading to the seat of the bleeding. Some authorities advocate dealing with the main trunk. Stromeyer and MacCormac are opposed to this practice, such operations having been uniformly unfavourable in their experience; they are more in favour of amputation in cases of secondary hæmorrhage. When not severe, it will probably be restrained by pressure and the elevation of the part. Pressure, when selected, should be applied directly on the bleeding point, by graduated compresses and bandages, and it will be of advantage, too, if it be put on the main artery or arteries leading to the aperture.

Nothing can be more disheartening than searching for a bleeding point in a suppurating unhealthy wound. If it is found, in all probability it will not hold a ligature; but it is more than likely that it will not be found. Should, then, the main artery be tied higher up, or should amputation be performed? In the experience of the writer at Suez † in 1884, several severe cases of secondary hæmorrhage, resulting from deep spear wounds, were controlled by ligature of the main artery of the limb. In one case deligation of the superficial femoral failed to check the bleeding, but tying the external iliac controlled it, and the man made a good recovery. It would seem, therefore, advisable in cases of this kind to tie the artery, if practicable, higher up first before proceeding to the graver operation of amputation. The true treatment is such antiseptic management of the wound from the first as will prevent septic inflammation and suppuration.

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* *Proceedings of Pathological Society*, 4th Dec., 1883.

† *A.M.D. Reports* for 1883. *Vide* Appendix III.

Hæmorrhage occurring from stumps may be primary, intermediate, or reactionary, and secondary. Primary hæmorrhage would be dealt with at the time of operation. Intermediate or reactionary may occur from reaction or from disease of the arterial coats, which may give a certain amount of warning by general oozing; or, in flap operations, where an oval opening having been made in an artery, the whole lumen of the vessel has not been included in the ligature.

Secondary, at a later period, when it may be from causes interfering with the formation of the coagula, or producing ulceration of the coats of the artery, or from septic causes as described above.

The treatment of hæmorrhage from a stump at an early period must be prompt; the maxim that holds good in primary hæmorrhage—not to interfere with a vessel unless it bleeds—will not answer here. Bleeding having occurred more than once, active measures must be adopted. After having tried elevation of the stump, the application of tourniquet, pressure by means of bandaging the stump so as to press the flaps together, and the application of cold to the wound and the adjoining parts, without checking the hæmorrhage, it will be necessary to open the wound, and make a search for the bleeding vessel.

It frequently occurs that there is some difficulty in isolating a bleeding vessel in a stump. It may then be secured by passing a curved tenaculum through the tissues immediately surrounding the vessel, and placing a strong ligature around the whole. It may also be secured by thrusting a needle armed with a ligature through the tissue in the direction of the bleeding vessel, and endeavouring to seize it along with the surrounding tissue.

If the vessels are softened, and will not hold the ligature, success sometimes attends the application of the solution of the perchloride of iron or the actual cautery.

In bleeding from a stump where the interosseous artery of the leg has been divided high up, hæmorrhage has been suppressed by a long acupressure needle being passed through the stump, so as to press the artery against one of the bones.

Should hæmorrhage occur at a later period, when the stump is irritable and inclined to slough, the surgeon may select one of the five following alternatives:—Apply a tourniquet; open up the stump and tie the vessels; ligature the main artery immediately above the stump; tie the vessel high up in the limb at a distance from the stump; or, lastly, amputate. Mr. Guthrie remarks on this description of hæmorrhage:—"In irritable and sloughing state of stump, hæmorrhages frequently take place from the small branches, or from the main trunks of the arteries in consequence of ulceration; and it is not always easy to discover the bleeding vessel, or when discovered to secure it on the face of the stump; for as the ulcerative process has not ceased, and the end of the artery which is to be secured is not sound, no healthy action can take place; the ligature very soon cuts its way through, and the hæmorrhage returns as violently as before, or some other branch gives way. Some surgeons," he says, "have, in such cases, preferred cutting down upon the principal artery of the limb in preference to performing another amputation, even when it is practicable; and they have sometimes succeeded in restraining the hæmorrhage for a sufficient length of time to allow the stump to resume a more healthy action. This operation, although successful in some cases, will generally fail, and particularly if absolute rest cannot be obtained, when amputation will be necessary. The same objection of want of success may be made to amputation; on a due comparison of the whole attending circumstances, the operation of tying the artery in most cases is to be preferred in the first instance, and if that prove unsuccessful, then recourse is to be had to amputation; but this practice is by no means to be followed indiscriminately."

"To obviate all doubt, the parts from which the bleeding comes should be well studied, and the shortest distance from the stump at which compression on the artery commands the bleeding, carefully noted; at this spot the ligature should be applied, provided it be not within the sphere of the inflammation of the stump. In case the hæmorrhage should only be restrained by pressure above the origin of the profunda, and repeated attempts to secure the vessel on the surface of the stump have failed, amputation is preferable to tying the artery in the groin, when the strength of the patient will bear it."

Intermittent Hæmorrhage.—A remarkable case of intermittent hæmorrhage, apparently due to malarial influence, occurred to a weakly soldier under my * own care at Netley. He had suffered in India from severe fever and ague, which culminated in disease of the left knee-joint, for which I amputated the leg through the condyles (Carden's method). The case progressed satisfactorily till the eighth day, when hæmorrhage from the stump set in, at intervals preceded by the cold and hot stages of ague. The usual local and constitutional remedies were tried without success, until sulphate of quinine was administered, when the hæmorrhage ceased, as well as the paroxysm of ague, and the man rapidly recovered.

Expedients for suppressing hæmorrhage may be divided into temporary and permanent, such operating either indirectly on the trunks conveying the fluid to the point, or directly on the orifice of the bleeding vessel.

In case of severe hæmorrhage on the field of battle, the first impulse on the part of the surgeon or his attendant is to check the bleeding by placing his fingers in the wound, or applying a tourniquet to the main trunk. The latter may not be available; it would, therefore, be necessary for an attendant to apply pressure with his fingers even during transport, in the event of the bleeding being from a large vessel.

Bleeding can frequently be checked by *plugging* a wound; but this may be followed by grave symptoms, in consequence of the blood becoming diffused, giving rise to an aneurism or to gangrene.

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* Porter's.

The tourniquet is the chief temporary means, which in its primitive state was simply a band to go round the limb, with a pad placed immediately over the vessel, and the whole tightened by means of a bayonet or piece of stick.

To Petit we are indebted for the screw tourniquet; and since his time there have been many modifications, nearly all with a view to stop the current of blood through the main artery of the limb, and at the same time to admit of a certain amount of circulation being carried on.

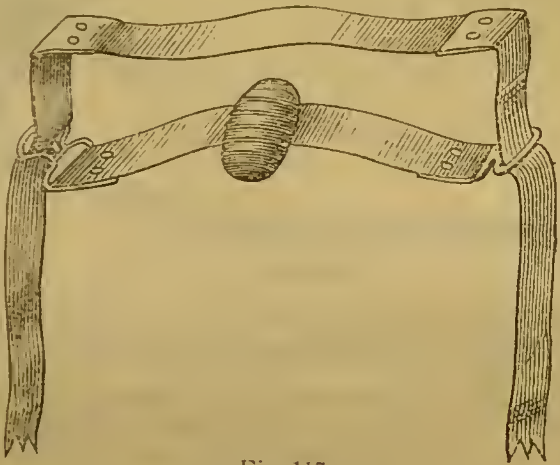

Fig. 117.

It was found that with wounded men having the old-fashioned twisted strap, or the more modern screw tourniquet, applied to a limb, and transported for any distance without surgical assistance, the tourniquet frequently shifted, or the man *lost the limb from gangrene.* To obviate this, and admit of a wounded man retaining the instrument for a considerable time, either during transport or until the services of a surgeon might be available, Dr. A. B. Mott, U.S.A., invented one with bands or hoops of iron or brass, which Mr. Hamilton describes as "a very ingenious field tourniquet (fig. 117), which is easily applied, and may be considered safe even in the hands of those who know nothing of the danger of ligating limbs too tightly, since the compression is applied at only two points in the circumference of the limb."

Professor Esmarch, in his work on bandaging, describes a tourniquet for the field invented by Volckers, which, he considers, on the lower part of the upper arm, can be applied with much less danger than the usual circular tourniquet. Volckers found it was easy to make the pulse above the elbow disappear, by crossing the arm with a stick at the proper angle of the axis of the bone. This apparatus (fig. 118) can be made with two little round sticks of about 8 inches in length, one for the inside, and the other for the outside of the arm, which he keeps in position by means of straps. On the centre of the inner stick he attaches a pad, which is placed immediately over the artery, and by tightening the straps is brought to bear on the vessel.

For pressure on the femoral artery in the upper part of the thigh, Professor Esmarch gives an illustration of an apparatus which can be easily constructed. A bandage is to be rolled on the middle of a stick at least a foot in length; then this bandage is to be placed against the artery,

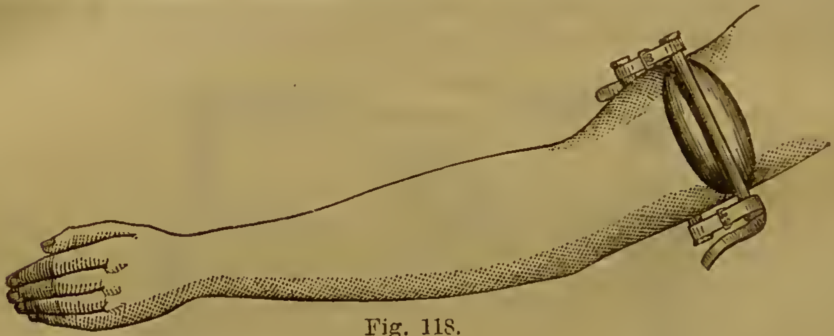

Fig. 118.

and tightened by means of a strap and strong buckle passed behind the limb and over each end of the stick; by this means continued pressure can be maintained (fig. 119).

Several ingenious modifications have been made of the ordinary screw tourniquet, whereby the strap is carried clear of the sides of the limb to allow of venous return. These have been effected by the addition of metal wings, over which the strap is carried.

Dr. John Hunter of the R.N. has designed three new forms of tourniquets which have the great advantage of allowing venous return.*

Tourniquets in the hands of surgeons have their undoubted advantages, but, at the same time, they are most dangerous in the hands of uninstructed men, who are exceedingly likely by the indiscriminate and prolonged use of them to cause gangrene of a limb.

The expedients that may be employed for the permanent arrest of hæmorrhage are—pressure, ligature, torsion, acupressure, flexion, cauterisation, application of cold, styptics, exposure to air, position, forci-pressure and application of hot water.

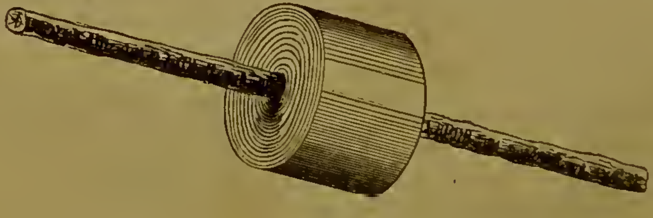

Fig. 119.

Torsion of arteries, though used in former times, fell into disuse, and was revived by Amussat and Velpeau. During the Franco-German War of 1870-71, Sir W. MacCormac appears to have used it with marked success. He says:—"I twisted the vessels in a very large number of cases of amputation for gun-shot wounds. I only remember a single instance of secondary hæmorrhage from a twisted vessel. It was a case of amputation through the knee-joint, in which acute pyæmia supervened. Torsion," he says, "is more difficult and tedious in its application than a ligature. It is inapplicable when the arteries are diseased."

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* *Lancet*, July 15, 1876.

It is doubtful if it is a safe expedient in the field, especially if it be necessary to transport the sufferer immediately after its application.

Sir W. MacCormac used unlimited torsion for the smaller arteries. For the large vessels lying loosely in unaltered sheaths, he considers it better to limit the length of artery twisted by grasping the vessel with a second forceps, otherwise the artery may be needlessly and dangerously disturbed in its relations to its sheath. He twists until he feels the internal coat giving way.

Sir Spencer Wells has introduced a new kind of artery and torsion forceps, which very conveniently replace the old spring artery forceps of Liston, and the bull-dogs used for the temporary stoppage of bleeding vessels during an operation, while they are the most readily applied of any of the varieties of torsion forceps met with.

The grasping and holding extremity is roughened by rather deeply-cut transverse teeth (fig. 120), so that the bleeding vessel is forcibly compressed and its coats almost crushed together. This is alone sufficient to stop the bleeding without any torsion, especially if the instrument be left on the vessel for a minute or more.

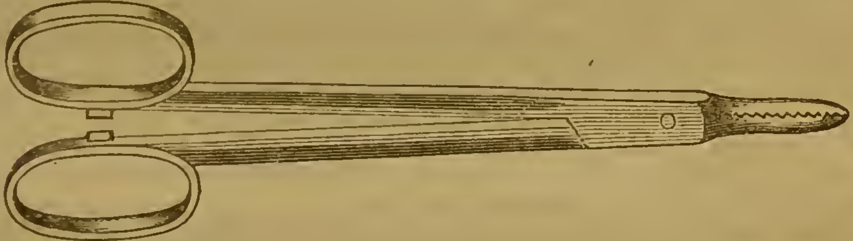

Fig. 120.

Acupressure may be applied in several different ways, the object in all being to compress the mouth or bleeding orifice of the artery against tissue or bone.

Flexion may be used for hæmorrhage from the forearm, hand, lower leg, or foot, by placing a piece of lint or handkerchief rolled up in the bend of the elbow or under the knee; then flex the limb and fix it. In the event of a tourniquet not being available, this proceeding might be used with advantage.

Cauterisation is now seldom used; at the same time it may be found of use in hæmorrhage from the surface of irritable and indolent stumps, or in gun-shot wounds of the tongue. It is recommended that the iron which is used for the purpose of cauterisation should be at a black heat, being considered more effectual in that condition than at a red or a white heat.

The application of ice or cold is nearly always attended by satisfactory results in wounds of very small vessels, favouring the coagulation of the blood. *Hot water* will accomplish this end more promptly than cold, and it is especially appropriate when the patient is feeble and exhausted by shock. It should be 150° F., and may be carbolised or iodised.

Styptics were much used in former days. They act by causing the blood to coagulate rapidly and firmly, but should only be used when there is oozing from parts where other applications cannot be conveniently made. Styptics are, as a general rule, most objectionable, as they act injuriously on the tissues to which they are applied, by causing much pain and tendency to extensive sloughing or suppuration, and thus rendering healing by first intention impossible.

The styptics occasionally used are the perchloride of iron, matico, turpentine, gallic acid, alum, nitrate of silver, chloride of zinc, Ruspini's styptic, and mineral acids.

Langenbeck has prescribed a solution of ergot in glycerine, to be used as a hypodermic injection in cases of hæmorrhage and in the treatment of aneurism: proportion—1 grain of ergotine to 6 minims of glycerine; two minims for an injection. This I* tried in two cases of aneurism without any satisfactory result, but I have seen it successful in cases of epistaxis and hæmorrhage from an intercostal artery.

Wounds of Veins.—Unless from some large and deep-seated trunk, hæmorrhage from wounded veins is seldom dangerous.

If a wound of the chief vein of an extremity is complicated with a wound of its artery, the case must be looked upon as most serious, being generally followed by gangrene of the limb.

If the vein wounded be of such a size that it would be dangerous to tie, the rent or tear in it may be closed by the uninterrupted or Glover's suture. Veins, if they bleed, may be tied as freely as arteries, though in ordinary cases pressure and elevation would be sufficient.

LIGATURE OF ARTERIES.

The instruments required for application of a ligature to an artery in its continuity are a scalpel, not too pointed, with a flat handle for pressing aside the tissues; a good-sized forceps; an aneurism needle; retractors; a ligature; needles and thread. In cutting down on an artery it may be only necessary to follow up a wound, which point should always be observed, the original wound being taken advantage of.

Mr. Erichsen gives such excellent instructions for cutting down on an artery, that they may be repeated here with advantage:—

"In making the first incision, the skin should be put on the stretch by the fingers of the left hand, or by those of an assistant. If the artery be superficial, or if there be parts of importance in its vicinity, the incision should not penetrate deeper than the skin. But if the vessel be deeply seated and no parts of importance intervene, it may be carried at once through the subcutaneous areolar tissue, until the fascia covering the artery is exposed. This must then be pinched up with the forceps, and opened by the edge of the scalpel laid horizontally. Through this opening a grooved director may then be passed, and the fascia incised on it, without risk to subjacent parts. The sheath of the vessel is now exposed by a little careful dissection; and the next step of the operation is one of great delicacy. It consists in exposing the artery and separating it from its accompanying vein. This is done by pinching up the sheath with the forceps and applying the knife horizontally. The artery having been exposed, the surgeon seizes one edge of the sheath with the forceps, and putting it on the stretch, gently separates the artery from its accompanying vein by tearing through the areolar connections with the end of the aneurism-needle, or with a director, being careful not to expose it to a greater extent than is absolutely necessary for the passage of the ligature. The ligature should be passed between the vein and the artery, care being taken only to include the latter, and especially not to transfix and include a portion of the vein. The artery should be tied tightly with a reef-knot, which does not slip" (fig. 121).

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* Porter.

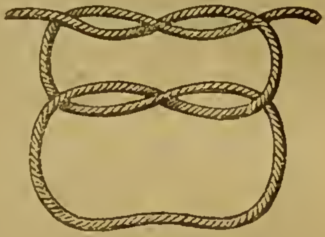

Fig. 121.

Catgut ligatures are now chiefly used, and to enable the catgut to acquire the necessary strength, it is prepared in a mixture of chromic and carbolic acid. After it is prepared for use it should be kept in a 1–5 solution of carbolic oil.

A specially prepared carbolised silk ligature is also used by some surgeons. Others, again, use ligatures of ox aorta and kangaroo tendons. When any of these specially prepared materials are used for tying arteries, after the knot has been securely tied both ends are cut off, and the knot remains in the wound until absorbed.

The following table may assist in showing when the separation of ordinary silk or thread ligatures from large arteries may be anticipated, at which period hæmorrhage may occur :—

Common iliac, 18th to 25th day; external iliac, 15th to 22nd day; femoral, 14th to 18th day; subclavian, 17th day; carotid, 20th day; brachial, 21st day; axillary, 22nd day.

The rules for tying the principal arteries have been taken from Mr. Heath's valuable work on *Operative Surgery*.

Ligature of the Common Carotid.—This operation may be performed above or below the omo-hyoid muscle.

Above the Omo-hyoid.—The patient must be placed on his back, with the shoulders supported by a pillow. An incision $2\frac{1}{2}$ to 3 inches in length is to be made exactly on the anterior oblique border of the sterno-mastoid muscle immediately opposite the larynx, so that the middle of the incision may correspond to the level of the cricoid cartilage. The incision should be carried at once through the platysma, superficial cervical nerves, and fascia to expose the muscular fibres of the sterno-mastoid. Should the external jugular cross the line of incision, it should be tied with two ligatures before being cut. The anterior edge of the sterno-mastoid is to be turned back until the angle formed between it and the omo-hyoid is clearly defined. The sterno-mastoid is then to be held back by an assistant while the operator dissects forward the outer edge of the omo-hyoid, which is then to be held with a hook, so as to increase the space between the two muscles. In doing this a large anterior jugular vein may be seen, and must be carefully preserved. The exact position of the artery being ascertained, the sheath is to be opened with knife and forceps directly over it. The outer side of the sheath being grasped with the forceps, the needle is to passed close to the artery from without inwards.

Below the Omo-hyoid.—An incision 3 inches in length along the anterior border of the lower third of the sterno-mastoid will allow that muscle to be reflected outwards (with or without division of its sternal attachments) until the muscles passing upwards to the hyoid bone are exposed. The outermost muscle is the omo-hyoid, and this is to be separated from the sterno-hyoid, when the broad sterno-thyroid will be seen beneath them, pushed up by the thyroid gland. The finger carried between the omo-hyoid and sterno-thyroid will distinguish the carotid in its sheath lying against the vertebræ. The sheath is to be opened with knife and forceps, and the artery fully exposed, without injuring the descendens noni nerve, when the needle may be passed from without inwards.

In these two operations the first incision should be exactly upon the margin of the sterno-mastoid, and the sheath of the artery should be opened well on the inner side to keep clear of the internal jugular vein.

The Lingual Artery may be most certainly tied at the apex of the digastric triangle beneath the hyoglossus. A curved incision beginning to the right (or left) of the symphisis menti is to be carried to the level of the hyoid bone, and then nearly up to the angle of the jaw. This should divide the platysma and expose the submaxillary gland without injuring it. The lower border of the gland is then to be turned up and held with a hook, when a little dissection will expose the two bellies and intervening tendon of the digastric, forming two sides of a triangle, of which the 9th or hypoglossal nerve is the base. The nerve will be seen to pass beneath the posterior border of the mylo-hyoid, which should be defined, and is usually accompanied by a branch of lingual vein. Both of these are to be dissected up a little, so as to bring the hyoglossus muscle, on which they lie, fully into view, and the hyoglossus is then to be divided transversely about $\frac{1}{8}$ of an inch above the great cornu of the hyoid bone, when the lingual artery with its venæ comites will be seen. The needle should be passed from above downwards. If the incision is carried up to or beyond the angle of the jaw, the large facial vein may be divided, and will require two ligatures. In dividing the hyoglossus, if the incision is made too deeply it will open the pharynx.

The Facial Artery may be tied immediately in front of the masseter on the margin of the lower jaw, by an incision, 1 inch in length, parallel to the fibres of the masseter. The artery lies upon the bone immediately beneath the platysma, and the vein is to its outer side. The artery is often tortuous.

The Subclavian Artery, in its third part, may be tied. In order to reach the vessel, the arm should be drawn down, and the head turned towards the opposite side. Standing at the shoulder of the patient, the operator draws the skin down upon the clavicle with the left hand, and makes a curved incision upon the bone, reaching from the sterno-mastoid to the trapezius. This incision should divide the skin, platysma, and fascia down to the bone, and with them the descending branches of the superficial cervical plexus, and possibly a vein, which should be tied at once if it bleeds. The skin being now allowed to resume its natural position, the incision will be about half an inch above the clavicle, and must be deepened by cutting carefully through the deep fascia thus exposed. The position of the external jugular vein having been ascertained, if it can be held on one side it should be preserved, but if it is in the middle of the incision it should be tied in two places, and divided between them. The finger introduced into the wound will be able to recognise the edge of the anterior scalenus and the first rib, with its tubercle, and possibly the artery and the cords of the brachial plexus. With the steel director and forceps, a cautious dissection is to be made in the direction of the artery, guided by the finger, until, by tearing through a process of fascia continuous with the scalenus, the vessel is exposed. The needle may be most conveniently passed from above downwards between the last cord of the plexus and the artery. The great risk is venous hæmorrhage, which is to be guarded against most carefully. The brachial plexus lies external to and behind the subclavian artery; the subclavian vein in front and below.

The Axillary Artery in its first stage. If it is necessary to tie the axillary, as in the case of a punctured wound, the operation recommended by Guthrie is probably the best. It consists in making an incision from the centre of the clavicle directly downwards, in the course of the vessels, to the middle of the anterior fold of the axilla. In this way the skin, superficial fascia, and greater pectoral muscle must be successively divided. The lesser pectoral will then be exposed, and the artery may be ligatured above or below this, without further division of muscular substance, or if it be thought desirable to deligate it under this the muscle must be cautiously cut through. When this is done, a very distinct and firm fascia will come into view; this must be picked up and carefully opened, when the artery and vein will be seen lying parallel to one another, the artery being to the outer side. The vein having been drawn inwards, the aneurism needle must be carried between it and the artery. The advantage of this operation is that the wound is open and free, and that constantly the artery can be more easily reached in any part of its course. The disadvantage is the great division of muscular substance it entails.

In its Third Stage.—The axillary artery may be readily reached when the arm is at right angles to the body. The operator should sit between the arm and the trunk, and an incision 3 to 3½ inches long is to be placed parallel to the anterior border of the axilla, at the junction of the anterior with the middle third of the space—*i.e.*, one-third of the whole width of the axilla behind its anterior border. Carried through the deep fascia, this will expose the axillary vein, which is to be drawn down by an assistant. The great cords of the brachial nerves will then be seen, and a little separation of these will expose the axillary artery between them. The needle should be passed from the inner side, or away from the vein, and the ligature must not be applied close to a branch. If the incision is made in the middle of the axilla, the vein will be to its outer side, and in great danger, and it will be difficult to expose the artery. The relation of the artery to the nerves being uncertain, it is easy to miss the vessel, or to mistake one of the cords for it. If the ligature were applied too close to the large subscapular branch, secondary hæmorrhage would be likely to occur.

Brachial Artery.—This operation may be performed in any part of its course. The middle of the arm is the best point to choose. A line drawn from the middle of the axilla to the inner side of the biceps tendon at the bend of the elbow indicates its course. The arm should be held by an assistant at right angles to the body without resting upon any support, which, if employed, is apt to push up the triceps muscle and displace the vessel. The fibres of the biceps should be exposed without dividing them.

The arm being abducted and rotated outwards, an incision should be made about 2½ inches long on the internal margin of the biceps. "The skin, which is always thin, and the facia should be carefully divided, and the deep fascia exposed. This is next to be laid open, but with care, for the basilic vein lies immediately below it, on the inner side of the brachial artery. The ulnar nerve will be found on the inner side of the vein, and the median in front of the artery, but there is no regularity in these relations ; much care is consequently required in finding the vessel."

When in doubt as to the recognition of ulnar or median nerve—the former in the middle of the arm will be found passing downwards and backwards.

The Brachial Artery at the Bend of the Elbow.—The position of the median-basilic vein having been ascertained if possible, a 2-inch incision, beginning at the level of the internal condyle, is to be placed parallel to, and usually above, the vein on the inner side of the tendon of the biceps, which is always to be readily felt, if not seen. The incision may be conveniently made from above downwards on both sides of the body, the operator being between the arm and the trunk on the left side. The bicipital fascia, varying much in thickness, will be exposed by the first incision, and on dividing it with the knife and forceps, or, if preferred, upon a director slipped beneath it, the artery with its two veins will be found between the median nerve and the tendon of the biceps. The needle to be passed from the nerve.

The Ulnar Artery, in the middle of the forearm, corresponds with a line drawn from the tip of the inner condyle to the radial side of the pisiform bone. This line marks the outer edge of the flexor carpi ulnaris. An incision 2½ to 3 inches long in the middle third of this line should be made to expose the deep fascia, through which the white tendinous margin of the flexor carpi ulnaris can be perceived. An incision carried along this will allow the handle of the scalpel to separate the flexor ulnaris from the palmaris longus, or the flexor sublimis digitorum, until the ulnar nerve is exposed at the bottom of the wound. To the radial border of the ulnar nerve, the ulnar artery will be found with its two veins. The needle should be passed from the nerve. If the incision is too much in front, the interval between the palmaris longus and flexor sublimis may be selected in error.

The Ulnar Artery at the Wrist.—An incision $1\frac{1}{2}$ to 2 inches in length is to be made along the radial border of the flexor carpi ulnaris immediately above the annular ligament. The first incision is to go through the fascia of the forearm, and expose the white border of the tendon. This being drawn inwards, another process of fascia will be seen binding down the ulnar artery, veins, and nerve to the flexors of the fingers. This fascia is to be picked up and opened directly over the artery, and, the veins having been separated, the needle is passed from the nerve, which is to the ulnar side of the vessels. The position of the pisiform must be correctly ascertained.

The Radial Artery in the middle of the forearm corresponds with a line drawn from the middle of the hollow in front of the elbow to the base of the metacarpal bone of the thumb. An incision, 2 to $2\frac{1}{2}$ inches in length, should be made in the middle of the forearm, and should be carried at once through the deep fascia. In thin persons the incision will expose the border of the supinator longus, but in a fleshy arm that muscle will overlap the artery considerably, and the border must be sought nearer the median line of the arm. The edge of the supinator is to be turned outwards, and the artery with its two veins will be found in the cellular interval between it and the pronator teres. The radial nerve is deeper than, and to the outer side of, the artery, and the needle should therefore be passed from the outer side. If the first incision is not made through the fascia, it is difficult to find the edge of the supinator. In reflecting this muscle, it is easy to miss the artery and expose the nerve to its outer side.

The External Iliac Artery may be tied by a curved incision 4 to 5 inches long. It will be best to begin 1 inch to the outer side of the middle of Poupart's ligament and an inch above its level, and to prolong it to a point an inch above the anterior-superior iliac spine. The first incision should expose the tendon of the external oblique; if the superficial epigastric artery is cut, it should be tied at once. The tendon is then to be divided to the same extent, the blade of the knife being held with its edge perpendicular to the surface in the whole length of the incision, and the muscular fibres of the internal oblique will be exposed. These are to be divided in the same way, the original curve of the incision being carefully preserved, until the transversalis is exposed. The muscular fibres of the transversalis are then to be divided in the original curve and by the same method, or a portion of muscle may be taken up with forceps, and divided, until the fascia transversalis is brought into view, when a director may be slipped beneath the remainder of the muscle, and the knife run along it. The fascia transversalis, which will now be exposed in the whole length of the incision, will be found to vary much in the quantity of fat it contains, being sometimes thin and transparent, and at others thick and well developed. It is to be picked up with forceps and carefully opened with the blade held horizontally, and the director being inserted, it is to be divided. The outside of the peritoneum will now be exposed. It is of a bluish appearance, and the bowels can be indistinctly seen through it. The operator with his forefinger carefully strips up the peritoneum from the iliac fossa towards the median line as far as the inner border of the psoas. The external iliac artery and vein will be found lying parallel to the inner border of the psoas in a distinct sheath of fascia, which must be opened with knife and forceps in order to expose the artery. The vein lies to the inner side of the artery, and the genito-crural nerve to its outer side; the needle should be passed from within outwards. If the incision is too near the middle line, there will be a risk of opening up the external abdominal ring or the sheath of the rectus, and of dividing the epigastric artery. If the incision is too low, it will interfere with the inguinal canal and spermatic cord in front; and behind, the trunk of the circumflexa ilii running between the internal oblique and transversalis will be divided. The curve and length of the incision must be carefully preserved, or it will be difficult to reach the artery, and each muscle should be finished before the deeper one is interfered with. In using the director, great care must be taken not to force it through deeper structures unawares, but, by moving it horizontally, to make it clear its way at the intended level.

The Femoral Artery may be tied at the apex of Scarpa's triangle and in Hunter's canal, the former being the preferable and more usual operation.

To tie the Femoral in Scarpa's triangle, the thigh is to be slightly flexed and abducted, the knee being bent, and in this position of the limb, a line drawn from about the middle of Poupart's ligament to the inner condyle of the femur, will mark the position of the upper part of the artery. An incision begun 2 inches below the groin and in the centre of the thigh, should be prolonged for 3 or 4 inches, and be carried through the fascia lata, so as to expose the sartorius crossing the lower part of the incision. A blunt hook being inserted at the inner edge of the fascia lata, the operator seeks the inner border of the sartorius, and turn the whole muscle outwards with his finger, when it is held aside by an assistant. Any small bleeding branch is now to be secured, when, if the incision has been properly made, and is not pulled out of position, the sheath of the artery will be readily seen at its lower part. The femoral sheath is to be carefully opened with knife and forceps, and especial pains taken to dissect well down to the true arterial coat on both the inner and outer sides of the vessel. The needle should be passed from within outwards. If the limb is not flexed and abducted, the incision will be made too much to the outer side. If the incision is too small, it is very difficult to displace the sartorius sufficiently. No attempt should be made to pass the needle until the artery is thoroughly cleared, or the vein may be perforated. Should such an accident occur, the hæmorrhage being controlled by pressure with the finger below the wound, the needle should be withdrawn, and separation of the vessels effected higher up, when the artery being carefully tied, the hæmorrhage from the vein will not recur.

To tie the Femoral Artery in Hunter's Canal, the thigh is to be flexed and abducted as in the previous operation. An incision 3 to 4 inches in length is to be made in the middle third of the thigh parallel to the inner border of the limb, and about an inch from the margin of the gracilis. This incision may expose the saphenous vein which is to be avoided, and the fascia lata is to be divided so as to expose the sartorius, which will be recognised by the direction of its fibres running obliquely downwards and inwards. The outer edge of the divided fascia being held with a hook, the operator seeks the outer border of the sartorius, and turns the whole muscle inwards with his finger. The tendinous expansion thrown across the vessels from the adductors to the vastus internus must now be opened over the artery, which can generally be seen through it, and the artery carefully isolated, when the needle should be passed from without inwards, avoiding the saphenous vein. If the incision is below the middle third of the thigh, the canal will not be exposed, but the popliteal space will be opened. If the incision is put too far from the inner border of the thigh, the vastus internus will be exposed, and may be mistaken for the sartorius, but its fibres are coarser and run in the opposite direction.

Posterior Tibial Artery in the leg may most certainly be reached when it lies between the superficial and deep muscles. The knee being flexed and the leg laid on its outer side, an incision 3 or 4 inches long is to be made in the middle third of the leg, parallel to the inner border of the tibia, and half an inch behind it. The edge of the knife should be turned towards the bone in making this incision, and the same direction maintained in the division of the muscle. The gastrocnemius will probably not be seen, but, if so, it should be drawn aside and the tendinous surface of the soleus exposed. This is to be divided for the whole length of the incision, with the muscular fibres beneath it, and a deep tendon which should be recognised and carefully divided on a director if preferred. By drawing the divided soleus outwards with a spatula, the posterior tibial vessels and nerve will be seen bound down to the deep muscles by the deep fascia, which varies much in thickness. The fascia being opened with a knife, the venæ comites should be separated from the artery with a steel director, and the needle passed from without inwards. If the incision is put too far from the tibia, the gastrocnemius will be found, and may be mistaken for the soleus. In dividing the soleus, if the knife is turned away from instead of towards the tibia, a much more extensive division of muscular fibres will result. If the incision be made too close to the border of the tibia, it is difficult to distinguish the soleus, and there is great risk of getting beneath the deep muscles and down to the interosseous membrane.

The Anterior Tibial Artery in the upper third. The limb being supported under the knee, so that the sole of the foot may be flat on the table, an incision begun at a point midway between the external tuberosity of the head of the tibia and the head of the fibula, and an inch below them, is to pass obliquely downwards and inwards from 3 to 3½ inches. The deep fascia of the leg is to be divided to the same extent, without injuring the muscles beneath, and then, with the forefinger and handle of the knife, the cellular interval between the tibialis anticus and extensor longus digitorum is to be sought, and the two muscles carefully separated. This interval can be more easily recognised with the finger than by the eye, but when opened up a muscular branch of the artery will usually be seen between the two muscles. Two broad spatulas must be employed to separate the muscles down to the interosseous membrane. The anterior tibial artery and veins will be seen lying on the interosseous membrane with the nerve to the outer side. The needle should be passed from the nerve. In using the finger to find the intermuscular space, it should be directed towards the tibia rather than the fibula.

In the Lower Third.—The tendon of the tibialis anticus can be readily felt through the skin, lying next to the anterior border of the tibia, immediately above the joint. An incision 2 to 2½ inches long on the outer border of the tendon of the tibialis anticus, and immediately above the anterior annular ligament, is to be carried through the deep fascia, so as to expose the tendon. To its outer side will be seen the tendon of the extensor proprius pollicis, which is drawn outwards with a hook, when in the interval between the two, the anterior vessels and nerve will be seen lying upon the tibia.

MORTIFICATION, OR GANGRENE.

Cheyne thus sums up the pathology of gangrene after operations and injuries:*—"First, It may result from direct destruction of the tissue at the time of injury, from injury to large blood-vessels, &c. Second, it may occur as the result of inflammation in a weak part. In this case the inflammation is set up by the growth of micro-organisms in the discharge or tissues of the wound, or by tension in the wound. Third, it occurs as the result of growth of bacteria in the tissues seen in phagedæna and traumatic gangrene."

In traumatic gangrene, or that induced by local causes, the parts may be so injured that they are killed outright, or cannot recover themselves, such as in cases of severe bruises, laceration, wound of the main artery or vein of a limb interfering with the circulation, which frequently happens in gun-shot fractures when splinters of bone or the missile wound the artery, or in punctured or incised wounds of a large vessel allowing of extravasation. It has also happened from a bandage being applied too tightly.

In the cases occasioned by severe lacerations or bruises (*local gangrene*), only the parts originally injured die, and there is but little necessity for surgical interference. The strength of the patient may be maintained by wine, nutritious diet, tonics of mineral acids, or quinine, and the patient's system, as far as possible, protected from poisoning by absorption of the decomposed putrid fluids which are in close connection with veins and absorbents by the use of antiseptic applications. The use of opium in these cases has a highly beneficial result, given in small and frequently repeated doses, or in full doses when there is great restlessness at night.

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* "Antiseptic Treatment of Wounds," p. 22.

In gangrene resulting from a wound of the main vessels, from compound fracture, or from any local cause, such as obstruction of the artery or vein (*distant gangrene*), the rule laid down by the older surgeons was to wait for the line of separation before the parts were removed by amputation. This practice has, however, been set aside for some years.

"In the treatment of local traumatic gangrene resulting solely from severe injury, the parts should be removed so soon as there are unmistakable signs of its death, the point of operation being selected as near the injured part as sound tissue can be obtained. But where the cause is due to defective power in the general circulation, consequent on a weak or diseased heart, with venous thrombosis, there can be no doubt that an immediate operation can be of no benefit to the patient, in as much as it can neither increase the power of the heart nor clear the obstructed vein, while the shock of the amputation and loss of blood may still further depress the patient's vital powers."

"The question of amputation from spreading traumatic gangrene, the result of inflammation is more complicated. The operation will cut off the supply of the infecting material, and the general experience of surgeons is almost universally in favour of amputation, and if this be performed well above the gangrenous part as soon as the disease is recognised, and the stump protected by every antiseptic precaution against new infection, the patient will have a fair chance of recovery."*—*Cripps.*

Mr. Guthrie gives two or three examples of the practice in extreme cases:†—"A soldier is wounded by a musket-ball at the upper part of the middle third of the thigh, and on the third day the great toe has become of a tallowy colour, and has lost its life: what is to be done? Wait—with the hope that the mortification will not extend."

"Suppose that the approaching mortification has not been observed until it has invaded the instep; what is to be done? Wait—provided there are no constitutional symptoms; but if they should be present, or the discoloration of the skin should appear to spread, amputation should be performed forthwith, for such cases rarely escape with life if it be not done. Where in such a case should the amputation be performed? I formerly recommended that it should be done at the part injured in the thigh. I do not now advise it to be done there at an early period, when the foot only is implicated; but immediately below the knee, at that part where, if mortification ever stops, and the patient survives, it is usually arrested; for the knee is by this means saved, and the great danger attendant on an amputation at the upper third of the thigh is avoided. When from some cause or other amputation has not been performed, and the mortification has stopped below the knee, it is recommended to amputate above the knee after a line of separation has formed between the dead and the living. This should not be done. The amputation should be performed in the dead parts, just below the line of separation, in the most cautious and gentle manner possible ; the mortified parts which remain being allowed to separate by the efforts of nature." In mortification of the fingers, hand, or forearm, from a wound of the axillary artery, the principle of the treatment should be the same.

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* *Holmes' System of Surgery*, vol. i., Art. "Gangrene."

† *Guthrie's Commentaries*, p. 25.

The result of amputation for traumatic gangrene is on the whole unfavourable, the disease frequently recurring in the stump (*recurrent gangrene*), or the patient sinking from exhaustion ; and in those cases where the tissues are already infiltrated or disorganised, the prospects from amputation are still more unfavourable.

Gangrene from Frost-bite and Severe Burns.—Erichsen lays down the principle that there are two exceptions to the rule of amputating in traumatic gangrene before the occurrence of the line of demarcation—viz., grangrene from frost-bite, and that from severe burns. During the severe winter of 1854, when the allied armies were before Sevastopol, the writer* witnessed several cases of gangrene of the feet from exposure, both in camp and in the trenches.

Those who were attacked by the disease in the trenches had their feet first wet by the mud and constant rain, when frost suddenly set in, and in consequence of the impossibility of moving about, the circulation became arrested.

Those who were attacked in camp found their feet numb and helpless on rising in the morning, having lain down on damp ground without removing their wet socks or boots, the result frequently being loss of both feet. The treatment adopted was to control the fever of reaction, support the constitution, and allow the dead portions to separate from the living, assisting them by the means already described in gangrene from laceration or bruises, and subsequently detaching with great care such parts as were disorganised. This gangrene may, to a certain extent, have been brought about by a scorbutic taint, as the ulcers which remained were most difficult to heal.

Spreading Traumatic Gangrene from inflammatory sepsis. "A small wound in persons of a vitiated constitution, or suffering from diabetes or Bright's disease, with small resisting power, may be followed by inflammation and death of the tissues in the neighbourhood of the injury, more especially if there is much swelling from effusion or hæmorrhage." Cripps writes : †—"The actual starting point of the disease is the inoculation of the tissues by the products of decomposition generated in the wound. The gangrenous process commencing in the neighbourhood of the wound, spreads upwards inch by inch into the infiltrated tissue, preceded by swelling and a dusky zone of inflammation. As the gangrene advances, the strength of the patient rapidly fails."

Closely allied to this is the acute spreading gangrene, Cheyne says:‡—"All the facts point to the spread of micro-organisms in the tissues as the cause of acute spreading gangrene and phagedæua. This is a most acute and fatal form of infective inflammation, following punctured, contused, or lacerated wounds, particularly when complicated with bone or joint injuries, and where there are facilities for the retention of putrid blood and discharge in the recesses of the wound."

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* S.-M. Porter.

† *Holmes' System of Surgery*, vol. i., Art. "Gangrene."

‡ "Antiseptic Treatment of Wounds."

Erichsen says:—"Spreading gangrene always sets in before suppuration is established, usually on the second or third day. The true nature of the affection, however, speedily becomes apparent." The inflammatory redness spread up on the inner side of the limb, and is quickly followed by gangrene.

Treatment.—It is of no use to wait for a line of demarcation. Erichsen says:—"Amputation should be performed at once. The only chance of safety lies in operating early, and removing the limb high above the part affected." Cripps writes:—"Of course, if the sufferer be obviously dying of general infection of the system, it is too late for any operation to be undertaken; but, if the patient be not in a state of collapse, amputation is imperatively demanded, and the chance of recovery depends upon the promptitude with which the operation is performed after the nature of the disease is recognised."

In any operation that is undertaken in this class of cases, the operator must take great care not to wound his own finger in its performance.

Idiopathic Gangrene, or that induced by constitutional causes, such as disease of the heart or arteries, diabetes or Bright's disease, requires notice. The dead part should be wrapped in some dry absorbent dressing, as iodoform gauze, boric, carbolised or mercurialised wool, &c. Cripps writes "that the best treatment in these cases is, that so soon as the thickness of the limb is clearly dead, and the line of demarcation formed, the offensive member should be removed, not by cutting through the living tissues, but by carefully separating the dead as high as practicable, without interfering with the living parts.

Bed sores (a form of gangrene from pressure which but too frequently comes under the notice of the army surgeon) arise from patients being obliged to lie for lengthened periods in the same position, after having undergone operations; or in the treatment of fractures of the lower extremities, probably without proper bedding, cleanliness, nursing, or fresh air; or in patients already debilitated from exposure and want of proper nourishment; and from injury to the spinal cord and other parts of the nervous system.

These sores generally appear on the sacrum, the trochanters, elbows, shoulders, heels, and back of the head.

The surgeon should ever be on the watch for them, as, in very weak subjects, they give but little warning of their approach or presence.

When there is a probability of long confinement, and the case is likely to be attended with constant decubitus, every precaution should be adopted, such as keeping the parts dry, the bedclothes smooth, and pillows arranged from time to time so as to prevent pressure on any particular spot.

Water and air beds may be used with great advantage, but in warm climates they are heating.

The skin may be hardened by the application of brandy, rectified spirits, solution of alum, tannin, tincture of iodine, collodion, or of bichloride of mercury composed of 2 grains to 1 ounce of spirits of wine.

When bed sores do occur, removal of pressure must be carried out by some means, which, on service in the field, requires ingenuity, as the usual mechanical contrivances found in permanent hospitals may not be present.

A sling for the more convenient treatment of bed sores has been designed by the author, which he used with advantage in cases where the sacrum and nates were severely implicated, and which may be applied in camp or in permanent hospitals.

The sling consists of a strip of West of England canvas, 18 by 24 inches. At either end it is stitched on two pieces of strong wood about the diameter of the common office-ruler, which keeps the canvas expanded when under the patient, and forms a means of fastening the stays, which are spliced together and attached to 3-inch blocks. These blocks have ropes passing through them and through blocks of the same size attached to poles or uprights (fig. 122), by which means the sling can be raised or lowered. A piece of canvas, round in shape, and 4 inches in diameter, is removed from the centre of the sling, through which the sores can be dressed or cleaned. In applying the sling, it is necessary to place a mattress doubled at one end under the patient's shoulders, the thin end extending to the loins. A pillow should be placed under the knees, and, except for dressing the sores, the patient should not be raised more than 1 inch off the bed.

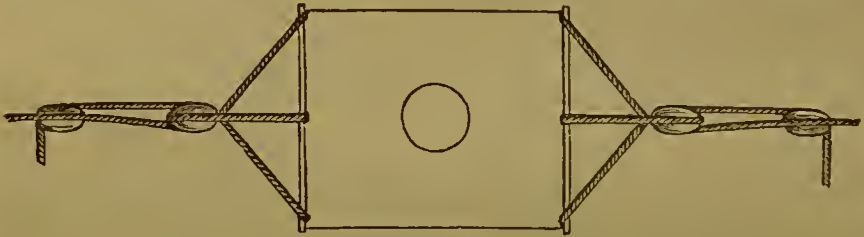

Fig. 122.

For local application, numerous remedies have been recommended. Cleanliness should be the first consideration, and the removal of sloughs if any exist.

Equal parts of castor-oil and balsam copaiba may be applied; this, in the hands of the writer,* has always been attended with success.

Balsam of Peru, either pure or diluted with the yolk of egg, spread on lint, or spirits and glycerine, are useful. Salicylic or boric acid ointment have been found useful spread on very thin linen, and warm astringent applications, such as the tincture of catechu, myrrh, iodine, and the resin ointment, have been spoken highly of.

The health of the patient must be carefully attended to, as, without improvement in it, the sores will not heal.

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* S.-M. Porter.

TETANUS.

There are two varieties of this disease—the idiopathic and traumatic; the former originating from cold or damp, particularly if the body has been previously exposed to heat and perspiring; and the latter from some kind of injury, in which exposure to cold may predispose to its attack, as occurred after the battles of Ferozepore and Chillianwallah, when the wounded were exposed during the cold nights, after very hard work during the day in a burning sun. It also occurred in Egypt under the same circumstances, as mentioned by Larrey; and after the battle of Ticonderoga, when the wounded were exposed the whole night after the action, in open boats, upon Lake George.

The symptoms in both are exactly the same, but they may vary in degree.

The experience of army surgeons is, that tetanus may supervene on every description and in every stage of wounds, from the slightest to the most formidable, in the healthy and sloughing, the incised and lacerated, the most simple and the most complicated; in all constitutions; in the strong and robust, and in the feeble and debilitated. It is, however, more apt to occur in debilitated subjects when the nervous system is lowered. It is more common in hot than cold climates. It occurs in all states of the atmosphere, but is most common during sudden changes of the weather.

Missiles, and also pieces of cloth that have not been extracted, appear to exercise some influence on the development of the disease.

Punctured wounds appear more liable to be followed by tetanus; and wounds of the extremities more than wounds in the head, breast, or neck.

Hamilton divides the causes of traumatic tetanus into predisposing and exciting—the predisposing being mental depression, climacteric influences, such as excessive heat, sudden vicissitudes of weather, and especially a rapid change from hot to cold and damp weather—it is more frequent in spring and autumn than in summer or winter—exposure of a portion of the body to cold draughts of air, an irritable temperament, physical exhaustion, disorder of the stomach and bowels, or a scorbutic taint.

The exciting causes are wounds--especially compound fractures—in which spicula of bone press upon nerve trunks; wounds accompanied with unhealthy suppuration, gangrenous sores, or those which from neglect are not kept properly cleaned; laceration, contusion, partial division or ligature of a nerve.

Professor W. C. Maclean is of opinion that excessive irritation of gunshot wounds, when they are in an inflamed condition before suppurative action has commenced, may give rise to tetanus;* jolting and disturbance of wounds by ill-constructed conveyances, has been given as a cause.

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* Longmore *On Gun-shot Injuries*, 1877, p. 248.

In temperate climates the disease seldom supervenes before the fourth or fifth day. In hot climates it may appear sooner; but it may take place at any period after the infliction of the injury, even after the wound has cicatrised.

Tetanus may be acute or chronic; the former proving in general rapidly fatal, and the latter continuing for a considerable period. The further the prolongation of the disease, the better are the prospects of recovery.

The disease is generally ushered in by a disturbed state of the digestive organs, with a feeling of malaise, a sense of weakness, and general depression; stiffness or soreness about the jaw, face, and neck; inability to swallow food or drink. As the disease advances, there is pain in the pit of the stomach, spasms of the voluntary muscles, the countenance assumes an aged and agonised expression, the angles of the mouth being drawn up (*risus sardonicus*). Cramps and pains will attack the muscles of the legs; difficulty of breathing will set in with a loud sobbing from spasms of the diaphragm. The skin will be hot, the pulse quick, and perspiration profuse, with a pungent odour. The mind in all probability will remain clear, but the sleeplessness will cause much distress.

The muscles of the trunk become affected, the body being sometimes bent back forming an arch (*opisthotonos*), or to one side; or the body may be straight, stiff, and rigid, with the belly drawn in and chest expanded; or the body may be arched forward (*emprosthotonos*). There may be constipation, but the sufferer will have perfect control of the bladder. The voice will be weak from spasmodic contraction of the muscles of the chest and neck.

The temperature generally becomes very high, particularly immediately before death, which occurs from exhaustion.

The sufferer may have short intervals of relief, the spasm being again induced by a slight current of air passing over the body, by taking food or fluids, or by shifting position or bed-clothes.

It has long been a subject of intense interest and consideration to discover what will relieve an unfortunate sufferer from this terrible disease, and offer some hope of recovery.

Older surgeons appear to have been helpless even as regards affording relief; and in the present day it is generally admitted that, though cures may be established in chronic cases, the acute disease always proves fatal.

Hennen remarks:—"Happy should I be could I afford anything satisfactory on this dreadful complaint; but, in truth, my observations have tended more to show me what I could *not* trust to, than what I could place the smallest reliance on, when the disease was fully formed;" and further on he says:—"I have never been fortunate enough to cure a case of Acute Symptomatic Tetanus; in some instances of the Chronic species I have effected or witnessed relief." Compare these remarks, written fifty-five years ago, with what Mr. Erichsen now says:—"Nothing can be more unsatisfactory than the treatment of the acute form of traumatic tetanus. In it all medicines are useless as curative agents; but though medicines are of no avail as means of cure, they may act as palliatives and afford relief to the patient."

The line of treatment must be local and constitutional, the former being with a view to removal of the irritation producing the disease. For this purpose, if there is a wound, it should be most carefully cleansed, and all extraneous substances, such as pieces of clothing, bullets, and splinters of bone, should be removed. If matter is pent up, it must be evacuated; and, if the wound is inflamed, an endeavour should be made to bring it to a healthy state, taking care at the same time to guard against changes of temperature by suitable coverings if the nights are cold.

Section of Nerve.—When tetanic symptoms have been induced by puncture or laceration of a nerve, Larrey recommended that the nerve should be divided, and was successful in the treatment. This expedient has also been adopted by others, and with satisfactory results.

Professor Fayrer, of Calcutta, mentions a case of tetanus caused by a wound of the hand, and relieved by section of the median nerve.

Excision of a portion of the injured nerve has been suggested.

Nerve stretching has been advocated by Mr. Milner, M. Verneuil, and Mr. Callender. The nerve is to be exposed and stretched when freed from its surroundings.

Amputation of the injured limb has been adopted, the better to remove all possible sources of irritation; this measure is not now advocated.

The remedies recommended for constitutional treatment are numerous, and probably afford relief in some cases, but are utterly worthless in others. The following may be mentioned:—Opium, cold and warm baths, cold affusion, hot-air baths, ice to the spine, bromide of ammonium, galvanism, bark, wine, spirits, mercury, purgatives, foxglove, tobacco, Indian hemp, musk, Prussic acid, iron, belladonna, turpentine, strychnine, woorali, ether, chloroform, chloral, Calabar bean. Hydrate of chloral has been used by Dr. Macnamara, of Calcutta, and Dr. Murray, of Dominica, advocates its use in combination with opium.

A case of tetanus having occurred, the bowels should first be relieved by a large turpentine enema, after which perfect quietness, in a darkened room free from noise or currents of air, must be insisted upon, as the best means of preventing the approach of spasm. The use of the ice-bag along the spine, as recommended by Todd, has afforded relief in allaying the spinal irritation, but is a great depressant. Chloroform has been extensively used, but without any permanent benefit. Hamilton remarks on this remedy, that "it has been tried very largely during the past few years, and, so far as we can learn, almost universally by our army surgeons, but not with a success which, in our judgment, would warrant its continuance, or, to say the least, its substitution for opium or morphine." After enumerating the various remedies proposed, he goes on to say:—"In our opinion, but few of these remedies are entitled to any special confidence; by far the largest mass of testimony having accumulated in favour of nutritious food, tonics, stimulants, and opiates, the latter of which, if employed at all, must be given in the most liberal and persevering manner; in some cases both by the mouth and by the rectum, or by the endermic method."

With regard to sedative and antispasmodic agents, Erichsen considers that they are of no use whatever in acute traumatic tetanus. "I have," he says, "seen many drugs of this kind employed without producing any effect in lessening the violence of the convulsions. In most cases, however, the inhalation of chloroform, or the administration of chloral, materially lessens their severity, and gives the patient at least temporary ease."

The Calabar bean has been used of late years with some success, but, like all other medicines, it has failed in many hands. It is a great depressant, and with it large quantities of stimulants should be given, as well as beef-tea, so long as the patient can swallow, or by enemata. The drug should be given frequently until the pupil is completely contracted. Dose, 1 to 3 grains; extract, $\frac{1}{16}$ to $\frac{1}{4}$ grain.

Surgeon-General Gordon reports that, during the siege of Paris, M. Demarquay saved several individuals who had manifested the early symptoms in the form of trismus, by means of very hot air-baths, followed by the injection of morphine under the skin, but the results in the fully developed cases seem to have been unfavourable.

Mr. Wagstaff of St. Thomas's Hospital records a successful case treated by profuse sweating, induced by the hot air-bath [persevered in for twenty-three days morning and evening.

The inhalation of nitrate of amyl has been recommended by Dr. W. S. Forbes of Philadelphia; 3 to 5 drops may be inhaled.

Professor Fayrer records two cases of traumatic tetanus treated and cured by opium smoking and internal administration of chloroform and hemp. Both patients were Hindoos. The average quantity of opium-goolie smoked daily by one patient was 84 grains. The chloroform and hemp were administered according to the following prescription :—

℞ Chloroform, ♏x.
Ext. of hemp, gr. i.
Mucilage, ʒi.
Camphor Mixt. ℥ss. Every six hours.

Stimulants and nourishment appear to give more prospects of success than any other means, and with the use of chloroform to lessen the spasms, perfect rest, quietness, and freedom from currents of air, the sufferer may withstand the exhaustion in the chronic form of the disease. On this line of treatment Sir T. Watson remarks :—"In all cases, there being *no* special indication to the contrary, I should be more disposed *to administer wine in large quantities and nutriment than any particular drug.*" These remarks are most significant and important.

HOSPITAL GANGRENE.

"Putrid Ulcer," "Phagedæna Gangrenosa," "Sloughing Phagedæna," "Pourriture d'Hôpital," "Gangræna Contagiosa," "Hospital Sore," "Wound Diphtheria."

Forms of Hospital Gangrene.—Delpech describes three forms, the ulcerative, the pulpous, and the gangrenous.

It is thus defined by Erichsen :*—"A rapidly spreading gangrenous inflammation attacking recent or granulating wounds. The gangrene follows closely on the inflammation. the dead tissue forming a pulpy adherent slough. There is febrile disturbance, but no specific infection of the whole system. It is associated with the growth of micrococci, and is intensely contagious."

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* *Science and Art of Surgery.* Eighth Edition.

Hennen* attributes hospital gangrene to bad air, want of cleanliness and ventilation, also to intemperance. Guthrie says:—"It originates only in badly-ventilated hospitals, crowded with wounded men, among and around whom cleanliness has not been too well observed."

Legouest, after pointing out the usual unsanitary conditions which are liable to promote this disease, remarks:—"Yet we have observed it in the most healthy hospitals, in well-ventilated corridors, in churches, in barracks, and even under canvas, and that under the most strict hygienic observances. Can it be averted, while large numbers of wounded are collected together in the same building? It may be propagated through the atmosphere, as an epidemic, or by contagion, by sponges, charpie, and dressings."

Blackadder is of opinion that at first it is a purely local affection, and that the constitutional symptoms do not make their appearance before the third, fourth, or, sometimes not till the eleventh day.

Hennen describes the disease, as it occurred at Bilbao, in the following words:*—"Let us suppose that our wounded have all been going on well for several days, when suddenly one of our most promising patients complains of severe pain in the head and eyes, a particular tightness about the forehead, want of sleep, and loss of appetite, and that these feelings are accompanied with quickness of pulse and other symptoms of fever; his wound, which had been healthy and granulating, at once becomes tumid, dry, and painful, losing its florid colour, and assuming a dry and glassy coat. This is a description of the first stage of our Bilbao hospital gangrene; and if a brisk emetic was now exhibited, a surgeon not aware of the disease that was about to form, would be astonished at the amelioration of the sore, and the unusual quantity of bile and indigested matter evacuated by vomiting. If, however, this incipient stage was overlooked, the febrile symptoms very soon became aggravated; the skin around the sore assumed a highly florid colour, which shortly became darker, then bluish, and at last black, with a disposition to vesicate, while the rest of the limb betrayed a tendency to œdema. All these threatening appearances occurred within twenty-four hours; and at this period also the wound, particularly if it was situated on a muscular part of the thigh, buttock, or calf of the leg, whatever might have been its original shape, soon assumed the Circular Form. The sore now acquired hard, prominent, ragged edges, giving it a cup-like appearance, with particular points of the lip of a dirty-yellow hue, while the bottom of the cavity was lined with a flabby blackish slough.

"This rapid progress and circular form of the ulcer were highly characteristic of hospital gangrene, and obtained almost universally, in every wound infected with it, wherever situated.

"The gangrene still advancing, fresh sloughs were rapidly formed, the increasing cup-like cavity was filled up and overtopped by them, and the erysipelatous livor and vesication of the surrounding skin gained ground, while chains of inflamed lymphatics could be traced from the sores to the adjoining glands, these exciting inflammation and suppuration, which often furnished a new nidus for gangrene. The face of the sufferer assumed a ghastly, anxious appearance; his eyes became haggard, and deeply tinged with bile, his tongue loaded with a brown or blackish fur, his appetite entirely failed him, and his pulse was considerably sunk in strength, and proportionally accelerated. In this stage the weakness and irritability of the patient was such, that the slightest change of posture, or the most delicate examination of the sore, put him to torture, increased by his inability to steady the limb, which, if moved at all from the bed, was seized with tremors and spasmodic twitches."

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* *Observations on Military Surgery.*

Mr. Hennen speaks of the torture of this disease as something terrible: "Men," he says, "who had borne amputation without a groan, shrunk at the washing of their sores, and shuddered at the sight of a dead comrade, or even on hearing the report of his death, instantly predicting their own dissolution, and sinking into sullen despair. The third and last stage was now fast approaching. The surface of the sore was constantly covered with a bloody oozing, and, on lifting up the edge of the flabby slough, the probe was tinged with dark-coloured grumous blood, with which also its track became immediately filled; repeated and copious venous bleedings now came on, which rapidly sunk the patient; the sloughs, whether falling off spontaneously, or detached by art, were quickly succeeded by others, and discovered on their removal small thickly studded specks of arterial blood. At length an artery sprung, which, in the attempt to secure it, most probably burst under the ligature. Incessant retchings soon came on, and, with coma, involuntary stools, and hiccup, closed the scene. Often, however, the patient survived this acute state of the disease, and sunk under severe irritation, absorption of putrid matter, and extensive loss of substance, without any other symptoms than those of hectic fever, arising from other sources."

The muscles may become extensively exposed or destroyed, leaving a cavity with tendons, vessels, and nerves stretched across from side to side. The bones sometimes become denuded of periosteum, or are attacked with the disease.

Blackadder, who records the disease as it appeared in himself, says it commenced with local symptoms. He wounded himself accidentally with a scalpel. In the course of about sixty hours the wound became inflamed, and he was occasionally attracted to it by a smart, stinging sensation, which ultimately extended a considerable way up the arm. On the fourth day the inflammation had increased, and the stinging sensation was almost constant; headache, nausea, and general indisposition followed, with frequent chills, which increased very much towards evening, but which, with other symptoms, were considerably relieved by the use of neutral salts, the pediluvium, and warm diluents. A vesicle, having a depression in its centre, and having a watery fluid of a livid colour, was now forming upon a hard and elevated base; the surrounding integuments became tumefied, of an anserine appearance, and extremely sensitive to the touch; at about the distance of the fourth of an inch from the base of the tumour, a distinct areola of a bluish-red colour made its appearance, and remained visible for several days. At this period circumstances rendered it necessary for him to be exposed to wet, to undergo considerable fatigue, and immediately afterwards to travel to a considerable distance. The inflammation, however, gradually subsided, but the stinging, accompanied by the burning sensation, still continued; and the sore had no disposition to heal, yet it did not enlarge externally, but was disposed to burrow under the integuments.

Mr. Taylor, late of H. B. M. 29th Regiment, experienced an epidemic at Ferozepore, in India. He remarks: "First, I could tell, by the peculiar dark florid countenance of the patient, that his wound had taken on the gangrenous affection; yet I cannot say that there was in these cases any marked inflammatory fever. In many cases the disease seemed purely local; but in the great majority there was certainly much feverish constitutional disturbance accompanying the local affection, and often preceding it."

The chief causes of this disease are overcrowding of patients and the putrefaction of the discharges from their wounds. "The air," writes M. Beck,* "is thus contaminated by the products of respiration, the exhalations from the bodies and excreta, and the effluvia from the decomposing animal matter, while the wounds themselves are rendered prone to suffer from infection by the irritation of the septic discharges in which they are bathed."

There is no doubt as to its highly contagious and infectious character, that it is capable of being transmitted by nurses, clothing, dressings, instruments, sponges, and atmosphere; that it attacks wounds in every stage and condition; that it can be inoculated; that it is generally caused by overcrowding of wounded, bad ventilation, want of cleanliness, privation, intemperance, and previous exposure, but that there are occasions when it occurs in the form of an epidemic, notwithstanding the most rigid and careful sanitary regulations; that it appears in all climates, in all seasons and weather, the wet and moist or very cold being most favourable to its production; and, finally, that there may be predisposing causes, such as patients having a scorbutic taint, an enfeebled constitution, or a nervous system depressed by the efforts of a severe operation.

The symptoms in every feature of the disease have been so well described by Hennen, Blackadder, and Taylor, in the foregoing remarks, that it is not necessary to repeat them.

With regard to the treatment of this formidable disease, no specific has as yet been laid down for its cure, but each medical officer who has had the misfortune to meet with it has recommended such treatment as he found most successful.

The first consideration of the surgeon will be to try and prevent a further spread of the disease, by removal of the infected patient from among the other wounded, and by prophylactic measures, such as the use of antiseptics, plenty of fresh air, strict sanitary arrangements in and about the hospital buildings, destruction by fire of all dressings, the total disuse of sponges, cleanliness among the patients, attendants, clothing, and bedding, evacuation of infected buildings, and fumigation of them.

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* *Erichsen's Surgery.* Eighth Edition.

The sufferer will have to be considered with respect to local and constitutional symptoms. For the former, all sloughs should be removed as far as possible, and an anæsthetic having been administered, the parts should be thoroughly swabbed out by a caustic such as nitric acid, acid nitrate of mercury, pure carbolic acid, chloride of zinc, &c.

Mr. A. E. Baker, of Dublin, who had some experience of the disease during the Franco-German War of 1870-71, while aiding the sick and wounded, says that the more active treatment employed with a view to arrest the ravages of the disease, consisted in the application of various caustics; thus liquor ferri sesquichloridi, chloride of zinc, acid nitrate of mercury, nitric acid, and the actual cautery, were all made use of; none of them, however, seemed to be of any service except the last; indeed, after the application of the chloride of zinc, the extent of the wounded surface seemed to increase more rapidly than before.

In the application of the actual cautery, he considers that, if only properly applied, it would always put a stop to the morbid action; but to bring this about, care had to be taken to let the effect of the hot irons extend beyond the tissues already the seat of the affection, and into the healthy structures further off.

Professor von Nussbaum, of Munich, testifies as to the great benefit to be derived from practising Lister's antiseptic dressings in the treatment of this affection. He writes:—"Hospital gangrene had got the upper hand to such an extent that 80 per cent. of all wounds and ulcers were attacked, and after five years' experience he states that any recent wound treated by this method is guaranteed against pyæmia, hospital gangrene, erysipelas, &c."—*Cheyne.**

Professor Volkmann, of Halle, gives a similar experience, he had an unhealthy hospital, yet, upon adopting Listerian dressings, infective diseases which were attacking every patient disappeared at once.—*Cheyne.*

Blackadder recommends the use of Fowler's solution of arsenic as an escharotic; he found that it answered well in arresting the progress of the disease at Passages and at Antwerp.

Constitutional Treatment will consist in giving whatever food and stimulants the patient can take and digest, combined with quinine, opium, ammonia, &c.

ERYSIPELAS.

Erysipelas belongs to the infective class of disease. It frequently attacks sick and wounded in civil and military hospitals, and seriously complicates surgical operations and injuries—it is undoubtedly contagious. Fehleisen says† it is due to the growth of micro-organisms in the tissues, the micrococci extend into the lymph spaces and canals of the skin, and he has produced erysipelas in man by the inoculation of the cultivated specimens of micrococci, but has never been able to discover them in the blood-vessels in true erysipelas.

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* *Antiseptic Surgery.* † "Micro-Parasites in Disease," *New Sydenham Society*, 1886.

It may occur sporadically, without any wound, lesion, or injury, in persons exposed to cold whose health is somewhat deranged, or in a wounded person predisposed to the disease, or by contagion or infection through contamination by dressings, attendants' fingers or clothes. It may occur as an epidemic, by over-crowding of hospitals, imperfect ventilation, noxious effluvia, or want of proper sanitation; by inoculation with putrescent animal matters in patients whose constitutions are already weak and debilitated.

The exciting causes may be local injury, wounds of any kind, contusions, fractures, sprains, lacerations, wounds of extremities, scalp wounds, and exposure to cold draughts. Lacerated and punctured wounds are more liable to its attacks than clean incised wounds; injuries about the head, hands, and knee appear especially so.

Erysipelas has generally been arranged in three divisions—"(1) The cutaneous; (2) the cellulo-cutaneous, or phlegmonous; and (3) the cellulitis or diffuse inflammation of the cellular tissue," which Fehleissen says is not erysipelas.

The first, or *cutaneous*, is known by redness of the skin, which disappears momentarily on pressure, with severe burning or smarting pains, and swelling from effusion into the cellular tissue. The intensity of the redness, which is the characteristic symptom of this disease, will depend very much upon the state of health of the patient, as in debilitated subjects it takes on more of a yellowish tint. In this form miliary vesicles, or large blebs, may appear about the third day, when they break and crust.

The constitutional symptoms of idiopathic erysipelas are thus described by Fehleissen:—" An initial shivering, the characteristic sharply-defined redness, the more or less rapid spreading on the surface (the so-called migration of the rose). the progress of the fever, and finally terminating in resolution, and healing without suppuration or abscess, confirm the diagnosis of true erysipelas." Traumatic erysipelas is of a more serious nature, and if there is a wound or granulating surface, it takes on an unhealthy action; the edges or surface become flabby, and covered with thin serum, instead of healthy pus; granulations become pale and more or less absorbed, or the wound may become dry and the edges swollen; and when there is a tendency in a wound to unite, the adhesions give way. On the other hand, an attack of erysipelas has sometimes a distinct therapeutic effect upon wounds and tumours.

In the second, or *cellulo-cutaneous or phlegmonous*, the redness is deeper, sometimes even dusky or purple; inflammation extends deeper into the tissues, and, if neglected, will terminate in diffuse suppuration or sloughing of them, extending even to the intermuscular septa, the sheaths of the vessels and tendons, or the tendons themselves; the swelling is much greater, is hard and brawny, pitting on pressure; the pain is severe and throbbing.

The constitutional symptoms will commence as in the cutaneous form, but more intensified; they will, however, soon assume a typhoid character if the patient is weak and has been subjected to much privation and exposure; but, if under the influence of proper treatment, and the patient is strong, the inflammation will subside and the disease will gradually disappear.

In the so-called third kind, a *cellulitis or diffuse inflammation*, the disease affects the connective tissue primarily, and the skin secondarily. It is characterised by the same local and constitutional signs and symptoms as phlegmonous erysipelas, but more intense. As the disease advances, the skin becomes mottled, livid in patches, and rapidly runs into blackish sloughs. It may extend to any distance up a limb, and even invade the trunk; it will also affect the sheaths of the vessels and tendons, and the tendons themselves. The joints may also become involved, and bones be denuded of periosteum and become necrosed.

The treatment which should be adopted in the first form must be, to clear out the stomach and bowels by an ipecacuanha emetic and mercurial purge. Then the condition of the patient as regards constitution, age, and previous habits will be the best guide. Should he be young and robust, spare diet and diaphoretics, with the local application of fomentations, will be sufficient; but in men who have been exposed to privations, or who may be debilitated from any cause, when the disease assumes a lower type, ammonia, bark, camphor, tincture of the sesquichloride of iron, wine, and nutritious diet should be administered. The tincture of iron and also of quinine have been found most beneficial, acting speedily.

In the milder forms, nothing cold should be applied. The part may be dusted with flour, starch-powder or peat-powder, and then covered up with cotton wool. Often hot fomentations of chamomile or poppy-heads will soothe the irritation that exists. Erichsen says—"At University College Hospital, the treatment recommended by Valette, of Lyons, has been tried in several cases with very good results. A 30 per cent. solution of perchloride of iron is prepared (roughly ℥i of solid perchloride to ℥iv of water), forty minims of this solution may be given internally every two or three hours, and externally the pure solution is applied to the inflamed area. Valette insists that this must be done thoroughly, the solution must not merely be painted on, it must be rubbed in with a piece of lint or cotton wool. The application is repeated twice a day as long as it is necessary."

In the cellulo-cutaneous form, the object is to prevent the inflammation running into a state of gangrene; for this purpose purgatives and diaphoretics should be administered in the first instance. If the disease advance to suppuration or gangrene, it will be necessary to support the patient by tonics, stimulants, and generous diet. The parts should be kept at rest and elevated. Fomentations, with chamomile or poppy-head applications, may soothe the disease, but if it become brawny, indurated, and tense, and likely to advance to suppuration and gangrene, incisions should be made to relieve the tension—several small ones being preferable to one long one. The wounds should be dressed antiseptically with warm wet antiseptic lint covered with waterproof. The parts having first been sprinkled with iodoform, the limb should be raised, and a smooth bandage applied firmly but evenly to assist the circulation in the weakened tissues, but iodoform cannot be relied upon alone, carbolic or sublimate lotion should be used in addition.

Burrowing of pus under the skin must be prevented by following up sinuses and dividing unhealthy vascular connections. Tissues in a state of slough or gangrene will have to be gently removed, as their presence may produce most serious consequences by their decomposed condition.

In the treatment of cellulitis, support may be required from the first. The local treatment is the same as in phlegmonous erysipelas.

The after-consequences of the cellulo-cutaneous form and cellulitis may be most troublesome, if the inflammation has extended to the sheaths of the tendons and the tendons themselves. There may be stiffness of joints and contraction of the fingers, wrist, elbow, and knee, where the tendons become so completely matted together that the motions may be seriously impaired, if not destroyed, or the joints and bones may be so diseased as to require amputation of the limb.

The army surgeon is most likely to meet with diffuse inflammation after shell wounds, or in wounds from splinters of wood. Soldiers doing duty in the supply departments, and employed in the slaughtering of animals, are very liable to the disease.

On the first appearance of erysipelas, the infected individual should be removed from the vicinity of the sick or wounded, or, better still, the sick or wounded should be removed from the vicinity of the erysipelas; the latter in most cases being utterly impracticable, all that the surgeon can do is to isolate the sufferer and prevent all communication between him and the other patients, hygienic measures being at the same time enforced.

PHLEBITIS.

Inflammation of the veins may be divided into two kinds—idiopathic and traumatic.

The *idiopathic* form as a primary affection is rare, it is usually connected with thrombosis, and is met with in gouty subjects and after fevers, and is found most frequently in the long saphenous vein, but occasionally in the deeper veins.

"Traumatic phlebitis," Erichsen says, "may be simple and local, or septic and spreading. The coats of a vein in the same way as any other tissue become inflamed, if submitted to any injury of sufficient intensity, whether it be the application of a ligature in a surgical operation, accidental mechanical violence, or the action of caustics. As the result of an injury, a clot forms within the vein, and ultimately may become absorbed, or the vessel may become obliterated. But, if the discharges of a wound are in a septic condition, the thrombus in the plugged vein may become infected with micro-organisms. It then softens and decomposes, and thus excites inflammation in the coats of the vein spreading beyond the part originally injured. Portions of the softened clot are washed on giving rise to dissemination of septic emboli and pyæmia. It is this that has been mistaken for the spreading inflammation of the vein as the primary affection, and led the earlier pathologists to associate phlebitis with pyæmia."

Diffuse septic inflammation in the cellular tissue may also involve the coats of the veins in the infected area.

The symptoms.—An enlargement of the vein, which becomes hard, swollen, painful, and knobbed, having a reddish-purple colour; stiffness, and severe twitches through the limb, with hard, tense feel, and pitting on pressure, from the state of œdema. Much stress has been laid on this latter symptom by some authorities as a diagnostic sign in deep-seated thrombosis, when the vein cannot be felt, and may be the first symptom noticed. "The œdema may give rise to a hard, white, and tense condition of the limb, which pits on pressure, though in some cases the hardness is too great for this."

These symptoms may be relieved under suitable treatment; but should the disease advance to suppuration, there will be high fever, shivering, and the usual symptoms denoting that it has taken place, or is about to do so.

The treatment at first will consist in most perfect rest; warm applications, such as fomentations, &c., and when the patient can bear it, the administration of saline purgatives.

Erichsen highly praises the application of extract of belladonna and glycerine in equal parts, covered by a thick layer of cotton wool and a bandage, but care should be taken not to disturb, irritate, or break the thrombus. If there is depression, it will be necessary to administer ammonia, bark, and stimulants. In suppurative phlebitis local abscesses may form, which run their course like other abscesses, and are bound and limited by inflammation, so preventing their contents entering the vessels and mingling with the current of the blood; they should be opened under antiseptic precautions, and the patient will require all the sustaining that is possible by food, wine, and medicine.

Diffuse phlebitis is generally pyæmic in character, and commences as an ordinary case of inflammation of the veins, but soon takes on alarming symptoms, characterised by extreme prostration, dry brown tongue, fluttering pulse, sordes on the teeth and mouth, diarrhœa, delirium, and death.

Such a case would require the same line of treatment as that recommended for erysipelas of the worst form, or pyæmia.

SEPTICÆMIA AND PYÆMIA.

Pyæmia and *Septicæmia* belong to the class of infective diseases. They are both due to the absorption of the products of putrefaction, but Koch* includes under the term septicæmia all those cases of general infection from a wound in which no metastatic changes occur. Others again have stated that septicæmia differs from pyæmia only in time, and that if the patient survived long enough secondary centres of inflammation would ultimately form.

Septic intoxication or sapræmia is a condition which may occur whenever the discharges from a wound are allowed to accumulate in sufficient quantity and to decompose. It is now thought that the fever accompanying large recent wounds, in which decomposing matter is in contact with the raw surface, is in great part or entirely due to the absorption of the poisonous chemical products of the putrefaction, and that this fever continues until the surface becomes covered by healthy granulation tissue, which is believed to prevent further absorption, unless the septic fluids are pent up in contact with it at some degree of pressure. The condition necessary for its rapid absorption would be found in all recent wounds, the raw surfaces of which, before they are covered by healthy granulation tissue form one of the most active absorbing surfaces conceivable. The poison does not multiply in the body, and, according to Koch, no organisms are found in the blood of animals suffering from septic intoxication. The term septic intoxication is used to express the condition when a sufficient quantity of the poison has been absorbed within a few days of the injury or operation to endanger life. The milder effects of the same poison are classed as traumatic fever, and the continued absorption of small quantities over a long period produces the condition termed septicæmia.

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* "Traumatic Infective Disease," *New Sydenham Society.*

Septicæmia is also applied to the condition due to *septic infection*, as distinct from septic poisoning. This is a true infective process, started in the organism by the introduction through a wound of some virus developed in decomposing organic matter. The poison multiplies in the body, and its effects are not directly proportional to the dose.

Cheyne writes* :—"Continued absorption of the poisonous material from wounds will keep up a feverish state, with all the symptoms of septicæmia. In other cases micrococci grow in the tissues of the wounds, and pour their products or ptomaines into the blood. Here micrococci may be found in the blood, but the essential seat of disease is in the tissues. In a third form, micrococci grow in the blood, and, multiplying there, give rise to the symptoms. In a fourth form, organisms grow in the blood, but they belong to the class bacilli."

"The symptoms of septic poisoning and septic infection are very similar—a chill or rigor on the second day, followed by feverishness, headache, loss of appetite, a quick pulse, and a dry furred tongue; delirium at night. On the third day after the injury, some disturbance of the alimentary tract sets in, vomiting is common, but diarrhœa is not frequent. In very acute cases symptoms of collapse quickly set in, the pulse becomes rapid, feeble, and irregular, the tongue dry and brown, and the lips covered with sordes; the temperature falls, consciousness is lost, and the patient may become comatose before death. Dyspnœa is a common symptom during the last day. The skin may assume a yellowish tint and purpuric spots appear, and the body evolve a sickly odour. The urine sometimes contains albumen."

"*Post-mortem Appearances.*—In extremely acute cases the signs of decomposition set in early, and the cutaneous veins mark the surface. Rigor mortis is often fully marked, the blood is often imperfectly coagulated, with visceral congestion, subserous petechiæ, early and intense *post-mortem* staining, and usually a swollen and softened spleen. In some cases there is pneumonic consolidation of the lung, and there may be pleurisy, with blood-stained effusion."—*Erichsen.*

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* "Antiseptic Treatment of Wounds," p. 23.

Treatment.—Locally through antiseptic treatment of the wound, plenty of fresh air, and everything that could sustain and strengthen the flagging powers, as wine, brandy, quinine, &c.

Pyæmia.—Professor Aitken[*] defines pyæmia as "a febrile affection, generally sequent on wounds, or on suppurative inflammation of bone, or surgical operations, resulting in the formation of secondary abscesses in the internal visceral organs (most frequently in the lungs, liver, kidneys, spleen, and brain), and also in joints and connective tissue, sometimes, but not necessarily, associated with phlebitis or embolism."

Pyæmia and septicæmia are said by Professor Ogoton to be only symptoms of micrococcus poisoning.

Marcus Beck writes:[†]—"In almost all cases of pyæmia micrococci can without difficulty be recognised in various situations. They are always present in the discharges and in the slough that so frequently covers the surface of the wound. They are always present in the fluids resulting from the softening of the thrombi in the vein. In the blood they are recognised with greater difficulty. Throughout all other parts of the body they have been observed in the purulent fluids in the secondary abscesses, but their most characteristic appearance is as colonies or zooglœal masses blocking the smaller arterioles or capillaries, and occasionally when a vessel has given way and inflammatory exudation has taken place, the group of micrococci seem to form the centre of a commencing abscess. The thrombosis, which forms a frequent precursor of pyæmia, is predisposed to by all the conditions which favour thrombosis in general, but it is usually determined in one of two ways. In many cases an unhealthy diffuse inflammation spreads upwards from the wound in the areolar tissue surrounding the vein. This leads to phlebitis and coagulation of the contained blood. The clot becomes impregnated with the products of the unhealthy inflammation, softens, and becomes disintegrated. In other cases, the thrombus forms in the vein, either in consequence of its having been divided and ligatured, or from death of the tissues, from which it derives its blood, as in necrosis of bone. If, under these circumstances, the distal end of the thrombus becomes exposed to septic matter as in a foul wound, the clot decomposes and disintegrates, a portion of softened clot may then be washed on into the circulation, and set up a centre for a secondary abscess.

Rosenbach[‡] divides the cases of pyæmia into two chief groups. The first is represented by cases which occur in connection with larger or smaller local affections, always, however, of considerable size, such as a suppurating joint or compound fracture, an abscess unopened or imperfectly opened, &c. The main point in these cases is that the general symptoms are maintained by local deposits, which are continuously supplying the body with morbid materials. Here we see the patients pine away and die with hectic fever, and often without any other note-worthy symptom. The second group consist of cases in which there is not necessarily anything worthy the name of a local centre. The infective material often enters through a small puncture, or scratch, or boil, &c. The main point in these cases is that a general pyæmic affection follows a single, often very transitory infection, without the presence of a permanent local centre.

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[*] *Science of Medicine.*

[†] *Erichsen's Surgery.* Eighth Edition.

[‡] "Micro-Parasites in Disease," *New Sydenham Society*, 1886.

Surgeon Sandford Moore, 4th Dragoon Guards, who had considerable experience when aiding the sick and wounded during the Franco-German War (1870-71), remarks:—"Pyæmia and hospital gangrene proved as great scourges as ever in the hospitals. It seemed extraordinary how these diseases appeared in some buildings and not in others, although both apparently presented the same conditions for attracting the disease." He also says that the diseases do not occur in hospital buildings until they have been occupied for at least ten days. He has not seen the diseases occur in a room for only one patient unless it was previously occupied by wounded, nor has he seen them occur among patients in the upper stories of a house. A room once poisoned, no disinfection or white-washing seems to be sufficient to drive away the poison immediately, for the remaining patients placed in the room speedily become pyæmic also; and men with slight as well as severe wounds take pyæmia.

"The attack is usually very sudden, coming on generally between the tenth and twentieth days after receipt of injury, and is marked by severe rigor, followed by profuse perspiration, which will in all probability leave the patient apparently well, but will recur in a day or so, producing great depression, the pulse becoming feeble, rapid, or variable, often intermittent, and the temperature high, but is subject to considerable fluctuation. The rigor may be preceded by secondary hæmorrhage, described as parenchymatous hæmorrhage, characterised by general oozing from the surface of the wound or stump.

"The sufferer may be attacked with cough, with or without expectoration, pleurisy, pneumonia, bronchitis, by peritonitis, pericarditis, or effusion in the head; but these complications may be entirely absent, or exist separately. The appetite disappears, the tongue becomes dry and brown, nausea, vomiting, and diarrhœa supervene, the countenance becomes yellow or jaundiced, delirium sets in at night. The temperature is subject to considerable fluctuations of a marked character, and perspirations are still more profuse and exhausting, preceded by severe rigors; abscesses rapidly form in the joints, or among the various tissues of the body; these are of a widely-spread character, and very insidious, as they often occur without any local signs (the pus sometimes infiltrating the cellular tissue and muscles of a trunk to a great extent), and are most frequently met with in the axilla, in the groin, back, iliac fosa, thigh and calf of the leg, giving rise to much suffering and exhaustion, from which the patient rapidly sinks. The disease may be at first mistaken for ague, rheumatism, or typhoid fever, but the continued rigors, followed by profuse perspirations, exhaustion, and suppuration, will soon declare the true nature of the disease."

The prognosis is most unfavourable. The disease is usually fatal; mild cases may recover, but when it is acute, when the rigors quickly follow one another, when the pulse is unsteady, the temperature high, and the patient restless, the disease will in all probability prove rapidly fatal.

The treatment consists in giving brandy, wine, ammonia, bark, quinine, and nutritious diet: above all, hygienic measures must be strictly enforced as far as possible, which may be a difficult point to attend to, when the accommodation may be limited, the weather inclement, and no means of preventing overcrowding. The surgeon should keep in view the experience obtained during the war of 1870–71, when it was observed that pyæmia occurred most frequently in permanent buildings; next in frequency in huts, and last of all in tents. Pure air is of the greatest importance, and one must ever remember the remarks of Sir J. Paget, who declares that *the few patients whom he had known to recover from the disease, owed their lives to being kept in a current of fresh air.*

The local treatment will require that free openings of all pus collections under antiseptic precautions must be established and perfect drainage maintained, and every means used by antiseptic applications to destroy and prevent any putrefaction that may have been set up in the wound discharges or the tissues themselves. But the great object must be to prevent this class of disease by such treatment of wounds as has been proved to be able to do so; and at the same time to remember that, in addition to the antiseptic local treatment, the surrounding sanitary conditions are of the first importance.

Operations during Pyæmia.—The opinion given by Sir J. Paget is, that, with acute pyæmia, in which the patient has rigors once or more in a few days, and profuse sweatings with very rapid pulse and breathing, and with delirium, and rapid wasting, or with dry tongue and yellowness of skin, or any considerable number of these symptoms, the probability of good is so small and of harm so great that you should refuse to operate. But if the pyæmia have become chronic, attended with only wasting and sweating and the formation of abscesses here and there, and if the injured part be manifestly useless, or a source of irritation or of exhaustion, the mere existence of pyæmia in the chronic form need not deter the surgeon from the necessary operation.

OSTEO-MYELITIS.

Inflammation of the medullary membrane may occur as a traumatic or idiopathic affection, the former being most likely to be met with in warfare, as the result of gun-shot injuries or amputation. It may, however, as Professor Fayrer * remarks, have its origin in any wound, injury, or contusion of the bone, or of its periosteum or medullary membrane; in sudden extremes of heat or cold, constitutional vice, such as syphilitic or strumous deposits of bone, or necrosis of the exterior extending inwards, and so causing mischief there. The occurrence of this disease after gun-shot injuries or amputation must be looked upon as most dangerous, in all probability necessitating excision of the injured bone, amputation, or disarticulation.

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* *Clinical Surgery in India.*

"Acute diffuse osteo-myelitis," writes Marcus Beck,* "is one of the most serious affections of bone. The traumatic is usually of septic origin, and is the direct consequence of decomposition of the discharges in a wound communicating with the medullary canal. The products of putrefaction diffuse themselves in the soft tissue of the medulla, and set up acute inflammation which rapidly ends in suppuration and often in gangrene of the marrow. It may result also from the virus of the various infective inflammations which attack wounds as erysipelas, hospital gangrene, &c., finding admission to the medullary canal."

Cheyne says : †—"The irritation may be due to organised irritants, such as the micrococcus and bacillus, which have the power of growing in the living tissues of the animal body. These organisms having gained access to the wound, may spread until they reach the periosteum or the medulla, and thus set up an acute septic periostitis or osteo-myelitis, with acute necrosis, and give rise to pyæmia. The death of the bone may not be confined to the exposed portion, but the suppurative inflammation may extend up beneath the periosteum or in the medulla, giving rise to acute suppurative periostitis or acute osteo-myelitis, in either case leading to the death of large portions of the bone, and very greatly endangering the life of the patient at the time."

It was remarked during the Franco-Prussian War, 1870-71, that gun-shot fractures, owing either to the nature of the missile or to the transport of the patients, were attended in a most remarkable manner by suppurative osteo-myelitis.

The presence of the disease may be suspected when, after an operation or injury, the patient is attacked with shivering, deep-seated pain, and swelling. If it be an amputated bone, the medulla will protrude like a fungus, and the periosteum will be detached from the bone, the soft parts retract, and the bone appear dry and discoloured.

Fayrer says : ‡—"The symptoms in this formidable disease are, in the outset, said to be obscure. .The local symptoms, no doubt, may be so when the affected bone is unexposed or undivided. The constitutional symptoms are those of pyæmia, and, at the outset, may be mistaken for a mere access of fever, a rigor such as may follow any surgical operation, or may occur from other causes. But as the local and constitutional symptoms progress, the doubt is soon cleared up. The symptoms, in the acute form, generally make their appearance early—within a week or ten days. It may be earlier, after the operation, wound, or injury. The stump, wound, or contusion may have been doing well. It may, perhaps, have sloughed a little, and the sloughs have cleared away, healthy granulations having appeared. The flaps may have united almost by the first intention, or all but at a point or two, whence discharge continues. The pain is not necessarily acute, and the tenderness on pressure of the stump is but slightly increased. The discharge becomes more profuse, but it is not healthy, well-elaborated pus. A probe being introduced, the bone is found dry and denuded, and, if exposed, the medulla will probably be found protruding like a fungus, whilst the periosteum is stripped from the end of the bone. With all this there may have been only a quickened pulse; or a febrile condition at some time of the day, the temperature at others being at, or even below, the natural standard; or rigors, as yet so slight as hardly to have attracted attention, may have occurred. Such are the early stage and symptoms, local and constitutional. These rapidly progress and develop themselves in the most marked manner. And now the critical period has arrived when it is necessary to make a thorough examination, and decide the question whether it be osteo-myelitis or not. Exploration should be made with the finger, the stump, if necessary, being sufficiently reopened to admit of doing so, and the condition of the bone should be carefully examined and ascertained. In incipient cases the medulla will be found protruding like a fungus, and the bone surrounding it exposed to a greater or lesser extent. At a later period, the end of the medulla is found already blackened and encrusted, but within it is a putrid mass of bone *débris* and pus—a probe readily passing down the entire length of the shaft. In the former stage you can wait and watch progress, the mischief may be limited, and a ring of bone be thrown off. But in the latter case immediate interference is necessary, and nothing less than amputation, either at or above the next joint, will suffice. The constitutional symptoms will also have indicated the necessity for interference, and they are the symptoms of *pyæmia* of a marked character."

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* *Erichsen's Surgery.* Eighth Edition. † *Antiseptic Surgery.*

‡ *Clinical Surgery in India.*

"The condition of the soft parts must not deceive. It is no uncommon thing to see the dead and putrid bone lying in the midst of perfectly healthy soft parts, and therefore the condition of the bone and the constitutional symptoms must be the guide as to the time and necessity for operation."

M. Jules Roux, in consequence of the fatal results of amputation and resection for this disease, proposed and carried out disarticulation of the injured bone. Of twenty-two cases in which he performed secondary disarticulation of joints for osteo-myelitis, all recovered; whereas every soldier died whose limb was secondarily amputated through the continuity of the injured bone, after the battles of Magenta, Montebello, and Solferino.

Fayrer urges the removal of the limb at the next joint above the affected bone. He says, in the cases of the hip and shoulder, disarticulation, of course, alone is practicable; whereas, in the leg and forearm, the respective advantages of disarticulation at the elbow or knee may fairly be questioned—and he has no hesitation in saying that, except in cases of endemic tendency to osteo-myelitis, section of the humerus or femur, in their lower third, is as good an operation as disarticulation, if not better than the latter. The great point to be attained is the removal of the whole of the suppurating bone. Whenever there is an endemic tendency to osteo-myelitis in a hospital, this disarticulation, though, in itself, inferior as an operation to section of the bone (according to his view in the case of the elbow and knee), should be preferred to amputation through the bone, as the fresh bone-wound might, under the endemic influence, give rise to a fresh attack.

Operative measures should be adopted at an early period, before pyæmic symptoms have commenced to appear, as, once that disease has set in, amputation, disarticulation, or excision are of no avail. It is, however, a difficult point to decide how long amputation may be deferred on the chance of the mischief being limited, and the diseased part thrown off without the constitution being affected.

The constitutional treatment in this disease should be improvement of the system by tonics, wine, nutriment, change of air, and strict attention to hygienic conditions.

SCURVY.

When scurvy presents itself among soldiers in time of war, it appears under different forms, such as swelling of the limbs, ulceration, especially of old cicatrices having a livid colour, and irregular tumid border, with a surface covered with a spongy, dark-coloured, strongly-adherent fœtid crust, dysentery, hæmorrhage, nodes, spongy swelling of the gums, and petechiæ, rendering the subjects quite inefficient, and *aggravating wounds or injuries* by preventing their healing.

* "Scurvy may be induced by deficiency of fresh vegetables, deficiency of nitrogenous food, probably also by deficiency of fat and by mere sameness of diet.

"It may be cured by the use of fresh vegetables, salts of vegetable acids, increased nitrogenous food, and by variety of diet.

"Once scurvy is set up in a body of men, dysentery, diarrhœa, typhus, rheumatism, ulcers, &c., are sure to break out, and it besides leaves the system totally unfitted to resist any epidemic poison that may present itself upon the scene, so that cholera and typhoid fever find easy victims."

† "Measures to be adopted in time of war, or in prolonged sojourn on board ship, or at stations where fresh vegetables are scarce, are—

"1. The supply of fresh vegetables and fruits by all the means in our power. Even unripe fruits are better than none, and we must risk a little diarrhœa for the sake of their antiscorbutic properties. In time of war every vegetable should be used, which it is safe to use, and when made into soups, almost all are tolerably pleasant to eat.

"2. The supply of the dried vegetables, especially potato, cabbage, and cauliflowers; turnips, parsnips, &c., are perhaps less useful; dried peas and beans are useless. As a matter of precaution, these dried vegetables should be issued early in a campaign, but should never supersede the fresh vegetables.

"3. Good lemon-juice should be issued daily (1 oz.), and it should be seen that the men take it.

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* *Military Hygiène*, Royal United Service Institution, 1870, by Professor F. de Chaumont, F.R.S.

† Parkes' *Manual of Practical Hygiène*, p. 492.

"4. Vinegar ($\frac{1}{2}$ oz. to 1 oz. daily) should be issued with the rations, and used in the cooking.

"5. Citrates, tartrates, lactates, and malates of potash should be issued in bulk, and used as drinks, or added to the food. Potash should be selected as the base, as there is seldom any chance of the supply of soda being lessened. The easiest mode of issuing these salts would be to have packets containing enough for one mess of twelve men, and to instruct the men how important it is to place them in the soups or stews. Possibly they might be mixed with the salt, and issued merely as salt." *

Iron, in the form of the tincture of the perchloride, in doses of 30 drops three times a day, has been recommended by Dr. Hammond for this disease. Attention should be paid to cleanliness, air, and exercise.

FOOTSORENESS.

Professor Parkes remarks:—" Footsoreness is generally a great trouble, and frequently arises from faulty boots, undue pressure, chafing, riding of the toes from narrow soles, &c. Rubbing the feet with tallow or oil, or fat of any kind, before marching, is a common remedy. A good plan is to dip the feet in very hot water, before starting, for a minute or two; wipe them quite dry, then rub them with soap (soft soap is the best) till there is a lather; then put on the stocking. At the end of the day, if the feet are sore, they should be wiped with a wet cloth, and rubbed with tallow and spirits mixed in the palm of the hand (Galton). Pedestrians frequently use hot salt and water at night, and add a little alum. Sometimes the soreness is owing simply to bad stockings; this is easily remedied. Stockings should be frequently washed, then greased. Some of the German troops use no stockings, but rags folded smooth over the feet. This is a very good plan.

"Very often soreness is owing to neglected corns, bunions, or ingrowing nails; and the surgeon must not despise the little surgery necessary to remedy these things; nothing, in fact, can be called little if it conduces to efficiency.

"If blisters form on the feet, the man should be directed not to open them during the march, but at the end of the time to draw a needle and thread through the blister; the fluid then gradually oozes out.

"All footsore men should be ordered to report themselves at once.

Chafing.—" Occasionally men are much annoyed with chafing between the nates or inside of the thighs. Sometimes this is simply owing to the clothes, but sometimes to the actual chafing of the parts. Powders are said to be the best—flour, oxide of zinc, and above all, it is said, Fullers' earth."

TREATMENT OF THE DROWNED.

First attempt the restoration of breathing, and secondly, after breathing is restored, the promotion of warmth and circulation.

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* Parkes' *Manual of Practical Hygiène*, p. 492.

Remove at once all wet clothing and wipe the body dry, cleanse the mouth and nostrils, and draw the tongue forward.

Place the patient on the ground with the face downward, and one of the arms under the forehead, turn the patient well and instantly on the side, supporting the head, and excite the nostrils with snuff, salts, or tickle the throat with a feather. Rub the chest and face warm, and dash cold water, or cold and hot water alternately, on them. If there be no success, instantly replace the patient on the face, raising and supporting the chest well on a folded coat or other article of dress. Turn the body very gently on the side and a little beyond, and briskly on the face, back again, repeating these measures cautiously, efficiently, and perseveringly about fifteen times in the minute, or once every four or five seconds, occasionally varying the side. On each occasion that the body is replaced on the face, make uniform but efficient pressure with brisk movement on the back between and below the shoulder-blades, or bones on each side, removing the pressure immediately before turning the body on the side. During the whole of the operations, let one person attend solely to the movements of the head and of the arm placed under it.

Should these efforts not prove successful in the course of from two to five minutes, proceed to imitate breathing by Dr. Sylvester's method, as follows:—

Place the patient on the back on a flat surface inclined a little upwards from the feet, and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder-blades. Draw the tongue forward, and keep it projecting beyond the lips; an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw, the teeth may be made to retain the tongue in that position. Remove all tight clothing from about the neck and chest, especially the braces. Standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards for two seconds. Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides.

Repeat these measures alternately, deliberately, and perseveringly, about fifteen times in a minute, until a spontaneous effort to respire is perceived, immediately upon which cease to imitate the movements of breathing, and proceed to induce circulation and warmth by commencing to rub the limbs upwards with pressure and energy. The friction should be continued under the blanket or over dry clothing; promote warmth of the body by the application of hot-flannels, bottles of hot water, heated bricks to the pit of the stomach, the armpits, between the thighs, and to the soles of the feet.

On the restoration of life, a teaspoonful of warm water should be given, and then, if the power of swallowing have returned, small quantities of wine, warm brandy and water, or coffee should be administered. The patient should be kept in bed and a disposition to sleep encouraged.

COOKING-PLACES.

"The simplest kitchen consists of a trench dug in the direction that the wind is blowing, of such width that the kettle, when placed on it, should not rest above an inch on each side. When the width is 9 inches, its depth should be 12 at the end from which the wind is blowing, and continue that depth for 4 feet, decreasing then gradually to 3 inches at the opposite end, where a space must be left equal to the breadth of the trench, to serve for a chimney. The fire is lit at the end where the trench is deep; it should not extend beyond 3 or 4 feet up the trench. The kettles are placed touching one another along this trench; dry sods should be used to stop up the chinks made by the roundness of the kettles, so that the space under them may form a flue. It is advisable to pile up sods, or, with stones and earth, to erect a chimney of at least 1 foot in height at the end away from the fire. All grass round the fire-places should be cut to prevent accidents from fire.

"These kitchens are susceptible of great improvement. The chimney can be made of mud, or wattle and daub, and the draught may be increased by using short pieces of hoop-iron, as bars stretched across the trench to support a filling-in of clay round each kettle, or in other words, to make a regular place for the kettle, into which it will fit exactly, so that its position may be frequently changed, to prevent the contents of one being cooked before the other. As the day following the wind may change to an exactly opposite direction, a similar trench must be dug in continuation of the former one, the same chimney being used. In this manner the same chimney will serve for trenches cut to suit the wind blowing from all four quarters. The openings from these trenches into the chimney must all be closed with a sod, except the one to be used when the fire is lit. In some places, where bricks or stones suitable to the purpose are to be had, it is better to construct these kitchens on the ground instead of below its surface.

"In well-wooded countries, like America, two logs rolled together in the direction of the wind, the fire being kindled between them, make a good kitchen. In such places fuel is no object, so the construction of chimneys can be dispensed with, and the kettles hung from a stick resting at each end on a forked upright.

Field Ovens.—"The simplest method of making them is as follows:—Take any barrel (the more iron-hoops on it the better), the head being out; lay it on its side, having scrapped away the ground a little in the centre to make a bed for it; or, if there is a bank near, excavate a place for it, taking care that the end of the barrel does not reach within 6 inches of the edge of the bank; cover it over with a coating of about 6 or 8 inches of wet earth or thick mud, except at the open end, which is to be the mouth of the oven. Pile up some sand or earth to a thickness of about 6 inches over the mud, arranging for an opening 3 inches in diameter being left as a flue (to increase the draught) to lead from the upper side of the barrel, at the far end, through the mud and earth.

This flue is only left open when the fire for heating is burning. When bread is put in, it should be covered over. Form an even surface of well-kneaded mud at the bottom within the barrel, to form a flooring to place the bread on. Light a fire within the barrel, and keep it up until the staves are burnt. You will then have a good oven of tough, burnt clay, tied together by the iron barrel-hoops. When required for use, heat it as if it was an ordinary oven. When the ashes are drawn out, and the bread put in, close the mouth with some boards, or a piece of tin or iron." *

LATRINES.

A latrine should be made as soon as the hospital arrives on the ground. A small shallow trench will suffice for one night.

In standing camps, latrines may be with seats, as shown in fig. 123. The seat being a simple pole, additional comfort may be given by adding a top pole to form a back; but this is quite needless, except for hospitals. The trench should be made as narrow as possible, and from 3 to 4 feet deep. Too much care cannot be bestowed in selecting the site of the latrine, and placing it so that no filtration from it may reach the water supply. A small piece of canvas may be carried to give some shelter to the latrine. If trees or brush are in the neighbourhood, it can be enclosed by a screen about 4 feet high. Twice a day, about 10 A.M. and 6 P.M., the bottom of the pit should be covered with a 3-inch layer of dry

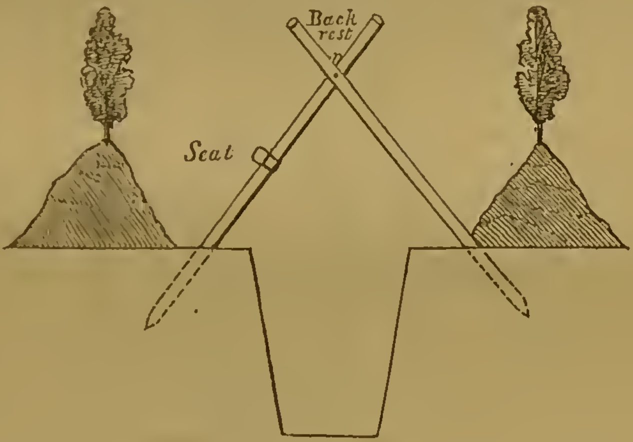

Fig. 123.†

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* *The Soldier's Pocket-Book*, by Col. Sir Garnet Wolseley, p. 152.

† Fig. 123 is taken from Regulations and Instructions for Encampments, Horse Guards, 1st August, 1871, plate xxvi.

earth. The wood ashes from the cooking-places should be spread about in the vicinity. Lime, if it is to be had, should be used in large quantities.

The health and comfort of every one in hospital depends very much upon the manner in which these duties are conducted.

WATER.

Pure water being so essential, the following instructions may be given here :—"When the halting-ground is reached, it may be necessary to filter the water. A common plan is to carry a cask, charred inside, and pierced with small holes at the bottom; it is sunk in a small stream, and the water rises through the holes. A better plan still is to have two casks, one inside the other; the outer pierced with holes at the bottom, and the inner near the top; the space between is filled with sand, gravel, or charcoal if procurable; the water rises through the gravel between the barrels, and flows into the inner barrel (fig. 124). It is advisable to heat sand, gravel, or earth to redness before use; the same applies to charcoal if there be any question of its purity. *All* these media must be changed frequently, or else purified by heating to redness.

"In the French army it is ordered that, if other means cannot be procured, fresh and inodorous straw be taken, and chopped fine, and pressed at the bottom of a tube pierced with holes; if possible, charcoal is to be intercalated among the straw. Great care must be taken to have the straw pure, and to change it often.

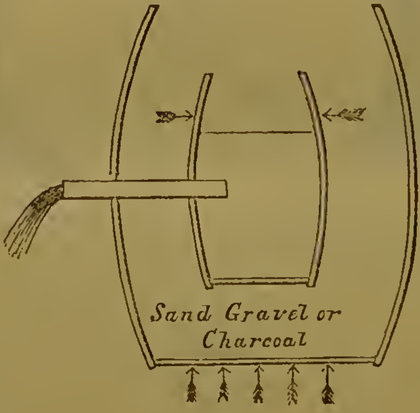

Fig. 124.

"Medical officers should make arrangements for the different places of supply. Men and cattle should be watered at different points; places should be assigned for washing; and, if removal of excreta by water be attempted, the excreta should flow in far below any possible spring. In case of a spring, several reservoirs of wood should be made, and the water allowed to flow from one to another—the highest for men, the second for cattle. If it is a running stream, localities should be fixed for the special purpose; that for the men's drinking-water should be highest up the stream, for animals below, washing lowest; sentries should be placed as soon as possible.

"The distribution of water should be regulated; streams are soon dried up, made turbid, and the water becomes undrinkable for want, perhaps, of simple management."

"Water may be filtered through a sponge, or a cloth of any kind; or by rolling a handful of grass in the form of a cone, and, having dipped it into the pool, allowing it to drip from one end."

In India, especially on board river steamers, where drinking-water is taken direct from the river, which is generally very muddy, a lump of alum is moved rapidly through it with satisfactory results.

In the Ashanti campaign of 1873, the water was purified by Surgeon-Major Gouldsbury's direction in the following way, in the absence of proper filters:—Alum was added to precipitate suspended matter—the water was passed through a rough filter, consisting of (1) sponge, (2) sand, (3) charcoal in pieces; it was then boiled, and a few drops of solution of potassium permanganate added. Water, even taken from a hole in a marsh, was innocuous after this treatment.*

As it is unlikely that any organic poison will resist the temperature of boiling, it is of the greatest importance that all suspicious water should be boiled before use. During epidemics, such as cholera, this is essential; it may even be advisable to try and supply the men with distilled water at such times: any sort of rough still would answer. One great advantage would be that impure water could not be substituted for it, as a few drops of solution of nitrate of silver would at once detect the presence of chlorides, which are present in all except distilled water.

In judging of water a few rough qualitative tests may be useful. 1st. Try as far as possible to get water that is clear, free from sediment, and colourless. 2nd. Test it with a little nitrate of silver solution and a few drops of dilute nitric acid; good water should give only a faint haze. 3rd. Add a few drops of Nessler's solution: good water should give no colour; a yellow tinge makes the water suspicious. 4th. Add a little permanganate of potash solution: good water should remain pink for about ten or fifteen minutes; if the colour fades rapidly or becomes brown the water is to be suspected. 5th. Add some solution of starch, a little iodide of potassium solution, and a few drops of dilute sulphuric acid; if a blue colour appears at once, or within a minute or two, the water is suspicious. Other tests may be added, but these are generally sufficient for practical purposes, while they entail the use of no special apparatus.

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* *Manual of Practical Hygiene*, 5th edition, p. 91. Edited by Professor de Chaumont.

WATER REQUIRED DAILY FOR ONE MAN, &C.

For cooking and drinking, . . .	6 pints, or 8 in the tropics.	
Ablutions, including baths, . . .	5 gallons.	
For personal and domestic use, without baths,	12	,,
,, ,, with baths,	16	,,

If the supply is running short, 4 gallons a-head per diem for all purposes is the least amount that ought to be given.

Elephants require	25	gallons daily.
Camels ,, ...	10	,,
Horses ,, ...	6	,,
Oxen ,, ...	6	,,
Mules and ponies require . .	5	,,

RATIONS.

The following is given as a type of a good war ration, which should be varied as much and as frequently as circumstances permit:—*

	Gross Weight.	Water.	Albuminates.	Fat.	Carbo-Hydrates.	Salts.	Alcohol.
	ozs.	ozs.	ozs.	ozs.	ozs.		oz.
Meat, 1 lb., less bone,	12·8	9·6	1·9	1·1	...	0·2	...
Bread, ...	20·8	8·0	1·6	0·3	5·9	0·3	...
Potatoes, ...	16·0	11·0	0·2	...	3·7	0·2	...
Vegetables (as carrots), ...	4·0	3·4	...	...	0·3	0·03	...
Peas or beans, . .	3·0	0·4	0·7	0·1	1·6	0·1	...
Cheese, ...	2·0	0·7	0·7	0·5	...	0·1	...
Bacon, fat, oil, or butter, ...	2·0	0·1	...	1·8	...	...	...
Sugar, ...	2·0	0·1	...	...	1·9	...	...
Salt, ...	0·5	...	...	...	...	0·5	...
Vinegar, ...	2·0	1·9	...	...	...	0·1	...
Condiments as required.							
Tea, ...	0·5	...	...	...	...	...	...
Or Coffee, ...	2·0	...	...	...	...	...	...
Or Cocoa, ...	2·0	?	0·3	1·0	0·5	...	...
Beer, ...	20·0	17·8	...	...	1·2	0·1	1·
Or Red wine, . . .	10·0	8·9	...	...	...	0·1	1·
Totals, . . .	86·3 to 74·8	53·8 to 44·9	5·7 to 5·4	4·8 to 3·8	15·2 to 14·	1·8	1·

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* *Military Hygiène*, by Professor F. de Chaumont, F.R.S., United Service Institution, May, 1870.

Vinegar is of great value as an antiscorbutic, and its use should be encouraged. Condiments are also most important. Fat has about two and a-half times the potential energy of the carbo-hydrates, but will not replace them, hence the value of bacon in the above scale. Bacon was issued for the first time as a ration in the late expedition up the Nile (1884–85), when it was greatly appreciated. For a scale of rations used on that occasion, see Appendix IV.

Professor de Chaumont writes:—"In cases of extreme fatigue, nothing so rapidly recruits the exhausted frame as Liebig's extractum carnis, and strongly recommends its issue to men before going on trench or picket duty in cold, wet weather, or to men on coming off heavy duty, cold and weary, often too fatigued to sleep. It can be prepared in no longer time than is necessary to get water heated, or it may be taken, less advantageous, cold."

*DAILY AMOUNTS OF WATER-FREE SOLIDS REQUIRED TO MAINTAIN HEALTH FOR AN ADULT MAN.

	In Rest.	In Ordinary Work.	In Laborious Work.
	Ozs.	Ozs.	Ozs.
Albuminates,	2·5	4·5	6 to 7
Fats,	1·	3·5	3·5 to 4·5
Carbo-hydrates,	12·	12·	16· to 18·
Salts,	·5	1·7	1·2 to 1·5
	16	21·7	26·7 to 31

* *Manual of Practical Hygiène*, de Chaumont.

On service, in the field hospitals, the sick and wounded are supplied with their usual daily rations, which should be supplemented by medical comforts, or by such articles as the Supply Department may be able to provide.

SPACE AND VENTILATION.

Army Regulations on the Space Allowed for each Man.

In Temperate Climates.

	Cubic Space.	Superficial Area.
In Barracks, ...	600 cubic feet.	50 square feet.
In Hospitals, ...	1,200 „ „	90–100 „ „
In the Tropics.		
In Barracks, ...	1,200 cubic feet.	90 square feet.
In Hospitals, ...	1,500–2,000 „ „	100–120 „ „

A bell tent is issued on service to every fifteen men; it measures in area of base (diameter, 12·5 feet) 123 square feet, and yields 497 cubic feet.—*Wolseley.*

The hospital marquee covers 396 square feet, and contains 3,366 cubic feet. It can accommodate ten men without cots and eight men with cots comfortably. By regulation it is intended to hold eighteen sick.

Parkes and de Chaumont give ·6 per 1,000 volumes of carbonic acid in the air as the limit of impurity allowable—of this, ·2 is derived from respiration, and the remainder is the normal quantity in the air.

To maintain the air at this standard, an ordinary man who inspires and expires 30 cubic inches at every respiration sixteen times in a minute, requires to be supplied with 3,000 cubic feet of air per hour. In order to get this without draughts, sufficient cubic space and superficial area must be allowed for each patient, so that the air would maintain this if changed three or four times in an hour.

The surface area per tent for different densities of population per square mile is as follows:—

No. of Square Yards per Tent.	No. of Tents per Square Mile.	No. of Troops per Square Mile.
50	61,952	929,280
100	80,976	464,640
500	6,195	92,928
1,000	3,097	46,461

Buck, in Vol. ii. of *Hygiène and Public Health*, gives the density of population in

	Per Square Mile.		
East London, . .	175,816	=	17·6 square yards per man.
Liverpool, . . .	138,224	=	22·4 ,, ,,
Manchester, . . .	100,000	=	30·0 ,, ,,
Philadelphia, . .	45,000	=	68·8 ,, ,,

To compare the density of population in a camp with the above, we must, as he points out, in our calculation divide the superficies of the Regimental Camp by the strength, and not the actual space occupied by a company, as towns and cities have every street, alley, and square included in the superficies.

For example, a Regiment of Infantry in open column of companies, when encamped, has a front of 320 yards and a depth of 266 yards, which gives 85,120 square yards; divide this by the strength, 1,096 men, and we have 77·6 square yards per man—or, taking a more compressed form in double companies, with only 15 yards between the companies instead of 40, we have a front of 120 yards and a depth of 150 yards.

120 × 150 = 18,000 square yards ÷ 1,096, gives 16·4 square yards per man, equivalent to 188,175 men per square mile.

But after all, the compression is not in the regimental but in the company lines, where fifteen men are packed into one badly-ventilated bell tent. Under these conditions, the Regulations of 1871 should be strictly observed. Company tents should never be arranged in double lines—short single lines are best. The tents in line should be separated from each other by a space at the very least equal to a diameter and a half of a tent. Whenever the troops remain in camp more than three days, tents should be struck every two days, all arms, straw, and blankets should be removed from the ground, and the ground should be swept clean and left exposed to the sun and wind. Whenever troops remain more than one night in camp, the tent flys should be rolled up the first thing every morning. In rainy weather the fly may be rolled up on the leeward side of the tent. Remember a camp is a temporary town without paving or proper drainage, hence the great care requisite to ensure a proper surface cleansing, &c.

The space between corps should be 25 yards or 30 paces—distances in Infantry Camps are usually reckoned by paces: 6 paces = 5 yards.

A square mile = 640 acres = 3,097,600 square yards.

APPENDICES

Nos. I., II., III., and IV.

APPENDIX I.

FORMULARY.

Alkaline Bath.

Take of—

Carbonate of soda,	4 oz.
Water,	30 C.

Mix.

Iodine Bath.

Take of—

Iodine,	¼ oz.
Solution of potash,	2 fl. oz.
Water,	30 C.

Mix.

Linseed Meal Poultice.

Take of—

Linseed meal,	4 oz.
Olive oil,	½ fl. oz.
Boiling water,	10 fl. oz.

Mix the linseed meal with the oil, then add the water gradually, constantly stirring.

Mustard Poultice.

Take of—

Mustard, in powder,	2½ oz.
Linseed meal,	2½ oz.
Boiling water,	10 fl. oz.

Mix gradually the linseed meal with the water, and add the mustard, constantly stirring.

Freezing Mixtures.

Take of— No. 1.

Sal-ammoniac,	5 parts,	Thermometer sinks from 50° to 10° Fahr.
Nitre,	5 ,,	
Water,	16 ,,	

Mix.

Take of— No. 2.

Snow,	Thermometer sinks from 32° to 0° Fahr.
Common salt,	

Mix.

Liniment of Sulphuret of Lime.

Take of—

Quicklime,	1 part.
Sublimed sulphur,	2 parts.
Water,	10 parts.

Mix.

Boil, constantly stirring with a piece of wood, until the lime and sulphur are *perfectly combined.* Decant, and keep in a well-stoppered bottle.

Wash the body well with warm water, and then rub the liquid into the skin for half an hour. For itch.

Carbolic Acid Solution.

Take of—

Carbolic acid,	1 part.
Water,	20 parts.

1–20—dilute with equal parts of water, it equals 1–40.

Boracic Acid Solution.

Take of—

Boracic acid.

Distilled cold water (60° Fahr.)

Dissolve as much as the water will take up.

Salicylic Acid Solution.

Same directions as for the boracic acid.

Mercurial Solution.

Take of—

Solution of the perchloride of mercury (B.P.),	1 part.
Distilled water,	1 part.

Mix = 1 in 1740; the liquor hydrargyri perchloride itself = 1 in 870.

The mercurial solution is coloured blue by Sir Joseph Lister, by means of an aniline dye.

The 1–500 solution is simply one part of corrosive sublimate dissolved in 500 parts of water.

It is only to be used of this strength for cleansing the skin, washing out the wound before stitching up in the case of an operation, or for purifying in the first instance an accidental wound.

Chloride of Zinc Solution.

Take of—

Chloride of zinc,	40 grs.
Water,	1 oz.

Mix.

Sir W. Burnett's solution of chloride of zinc contains 300 grains in one ounce, therefore if diluted with 7½ parts of water it will equal 40 grains in one ounce. To purify sick-rooms, night-chairs, cesspools, privies, add 1 part of Burnett's solution to 100 parts of water.

Chlorinated Soda Solution.

Take of—

Liq. Sodæ Chloratæ,	1 part.
Water,	9 parts.

Useful as an application to unhealthy wounds.

Eucalyptus Oil.

Take of—

Eucalyptus oil,	1 part.
Olive oil,	10 parts.

Boracic Acid Ointment.

Take of—

Boracic acid,	1 part.
White wax,	1 part.
Paraffin,	2 parts.
Almond oil,	2 parts.

First mix the wax and paraffin by heating them together, then add the oil. Mix the crystals with this in a warm mortar, and continue the process of mixing till the liquid solidifies. The half strength contains half the quantity of boracic acid.

Boracic lint is ordinary surgical lint soaked in a hot saturated solution of boracic acid and then hung up to dry.

The expression of so many parts in a 1000, in exact measurement, is 1 gramme in a litre.

1 gramme = 15·43 grains (or 1 c.c.)

1 litre (1000 c.c.) = 1·76 pints. For rough calculation 1 grain may be taken to equal 1 minim.

APPENDIX II.

ANTISEPTICS CONTAINED IN

	Quantities.	Where placed.
Field Medical Companion.		
Vaseline, antiseptic,	1 box.	
Bandages, first dressing (Esmarch),	No. 2.	
Boric wool,	2 oz.	
Sulphuro-chromic catgut ligatures, in leather case,		
Surgical Haversack.		
Lint, antiseptic, carbolised,	4 oz	
Loose arm bandages, antiseptic,	No. 4.	
First dressing bandages, antiseptic,	3	
Boric wool,	2 oz.	
Medical Field Panniers.		
No. 1.—MEDICINE PANNIER.		
Acid, boracic,	2 oz.	In body of pannier.
,, carbolic cryst.,	4 oz.	
,, ,, liq.,	4 oz.	
Iodoform,	2½ oz.	
Vaseline, antiseptic,	1¼ lb.	
Zinci chlor.,	1 oz.	Drawer No. 3.
No. 2.—MATERIAL PANNIER.		
Lint, antiseptic,	8 oz.	Basket A.
Cotton wool, antiseptic,	1 lb.	Basket B.
Antiseptic gauze,	6 yds.	Wrapper.
Silk, protective,	2 yds.	
Tenax,	1 lb.	Tin C.
Carbolised cat-gut,	6 hanks.	,,
Drainage tubing,	6 yards.	,,
Field Fracture Box.		
Cotton wool, antiseptic,	½ lb.	
Tow, carbolised,	½ lb.	
Flannel serge, antiseptic,	2 yards.	
Surgery Waggon.		
Acid, carbolic,	8 oz.	Basket A.
,, ,, liq.,	2 oz.	
Hydrarg. perchlor.,	2 oz.	
Iodoform,	6 oz.	
T. benzoin co.,	12 oz.	

Surgery Waggon—continued.

	Quantities.	Where placed.
Vaseline, antiseptic,	2½ lbs.	Basket A.
Zinci chlor.,	4 oz.	,,
Sulphuro-chromic catgut,		
Wire, silver,	1 oz.	,,
Bandages of kinds,	101	Basket B.
Boric wool,	8 oz.	,,
Carbolised gauze,	6 yards.	,,
,, tow,	1 lb.	,,
Lint, antiseptic,	2 lbs.	,,
Protective,	2 yards.	,,
Macintosh,	3 yards.	,,
Bandages,	76	Basket C.
,, first dressing,	20	,,
,,	15	Partition under bskts. 1 & 2.
Boric wool,	5 oz.	,,
Carbolic gauze,	6 yards.	,,
,, tow,	1 lb.	,,
Lint, antiseptic,	2 lbs.	,,
Protective,	2 yards.	,,
Macintosh,	3 yards.	,,
Boric wool,	1½ lbs	Basket D.
Bandages,	200	,,
Carbolised tow,	3 lbs.	,,
Boric wool,	½ lb.	Basket F.
Lint, antiseptic,	16 lbs.	,,

Special Surgical Panniers.

No. 1 PANNIER.

All appliances are antiseptic.

Acid, carbolic,	8 oz.	Tin A.
Iodoform,	1 lb.	
Drainage tubing,	12 yds.	Tin B.
J. R. bottles for washing wounds,	4 yds.	
Gauze,	1½ yards	In lower division.

No. 2 PANNIER.

Boric wool,	1 lb.	

Reserve Medical Field Panniers.

No. 1.—RESERVE MEDICAL PANNIER.

Acid, boracic,	4 oz.	In body of pannier.
,, carbolic cryst.,	4oz.	
,, ,, liq.,	4oz.	
Iodoform,	5 oz.	
Vaseline, antiseptic,	2 lbs.	
Zinci chlor.,	2 oz.	
Iodoform, in 2 stoppered bottles,		Drawer No. 2.
Drainage tubing,	12 yards.	Drawer No. 3.
Bandages, first dressing,	No. 10.	Drawer No. 4.
Lint, antiseptic,	1 lb.	

No. 2.—RESERVE MATERIAL PANNIER.

Gauze, antiseptic,	12 yds	Tin A.
Silk, antiseptic, protective,	4 yds.	
Tenax,	1 lb.	
Wool, antiseptic,	1 lb.	Tins C and E.

	Quantities.	Where placed.
Pharmacy Waggon.		
Acid, boracic,	8 oz.	D compartment, slide 2.
,, carbolic,	8 oz.	D ,, ,, 2.
,, ,, liq.,	2 oz.	D ,, ,, 6.
Collodion,	4 oz.	D ,, ,, 2.
Hydrarg. perchlor,	6 oz.	D ,, ,, 6.
Iodum,	8 oz.	D ,, ,, 2.
Iodoform,	3 oz.	D ,, ,, 3.
Liq. Sodæ chlor.,	2 oz.	D ,, ,, 1.
Zinci chlor.	8 oz.	D ,, ,, 2.
Bandages, antiseptic,	No 524.	A ,, drawer 1, 2, 3.
Ligature, catgut,	6 hanks.	A ,, slide 3.
Lint, antiseptic,	70 lbs.	B ,,
,, marine,	36 lbs.	B ,,
Silk, protective,	4 yards.	D ,, ,, 4.
Tow, carbolised,	28 lbs.	B ,,
Wool, salicylic,	6 lbs.	E ,,
Drainage tubing,	12 yards.	D ,, ,, 4.
Irrigators,	1 set.	D ,,
Sulphuro-chromic catgut,		D ,, leather case
Large Fracture Box.		
Tow, carbolised,	2 lbs.	
Cotton wool, antiseptic,	1 lb.	
Flannel serge, antiseptic,	2 yards.	
Medicine Chest.		
Acid, carbolic liq.,	4 oz.	
,, ,, crystal,	2 oz.	
Hydrarg. perchlor.,	3 oz.	
Iodoform,	2 oz.	
Iodum,	3 oz.	
Liq. sodæ chlor,	8 oz.	
Zinci chlor,	12 oz.	
Vaseline, antiseptic,	2 lbs 8 oz	
Zinci chlor.,	2 oz.	
Sp. rectif.,	8 oz.	
Bandages, various,	34	(12)
Gauze, antiseptic,	6 yards	(10)
Ligature, chromic catgut,		Leather case.
Lint, antiseptic,	2 lbs.	(10)
Wool, antiseptic,	1 lb.	(7)

Note.—When dressings are said to be antiseptic without further explanation, no information is given in the Regulations.

Note.—THE FIRST FIELD DRESSING.*—The first field dressing is a packet which measures 4·5″ × 3·25″ × ·87″, weighs 4 oz., and is intended to be carried in the soldier's breast pocket on service. It contains two pads of carbolised tow, designed to cover the wound of entrance and exit; a carbolised gauze bandage to secure the pads in position; a triangular bandage to form a sling, &c. the whole being encased in a tinfoil wrapper and parchment cover, which serves to prevent evaporation of carbolic acid and protect the contents from grit, dust, and damp.

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* Par. 189, Part ii., *Manual for Medical Staff Corps*, 1885.

APPENDIX III.

The following Orders have recently been issued to the Medical Department of the German Army:—*

INSTRUCTIONS FOR PREPARING AND APPLYING ANTISEPTIC BANDAGING MATERIAL (SUBLIMATE BANDAGES).

A. *Preparation.*

1. The preparing of the antiseptic bandaging material, which the Sanitary Detachments for the field have to carry with them ready impregnated, is done after the order of mobilisation, but before leaving the locality from where they are mobilised, and this has to be done by the field apothecary. *N.B.*—The same rule extends to the roller bandages covered with powder of plaister of Paris.

2. *Sublimate Gauze.*—The antiseptic fluid used for preparing the gauze is composed according to the following formula:—

Bichloride of mercury, . . .	50 parts or grammes.
Spirits of wine, ...	5000 ,,
Distilled water, ...	7500 ,,
Glycerine, ...	2500 ,,
Fuchsin, ...	0·5 ,,

This quantity in grammes suffices for the saturation of 400 metres of gauze.

By the addition of fuchsin it is intended merely to give a red colour to the gauze in order to distinguish it from non-prepared material.

3. The gauze should be dipped into the antiseptic fluid and well kneaded. After fifteen minutes, it should be removed and well squeezed, and then hung up on a line to dry. The drying must be done without exposure to the sun, otherwise the fuchsin gets bleached. The drying takes about twelve hours in a room not heated, or nine hours in a room heated to 65° F.

4. Should circumstances require a more rapid preparation, then the water in the formula may be substituted by spirits of wine.

5. After the drying (the gauze will still feel somewhat moist owing to the glycerine), the pieces of gauze (40 metres) should be folded up smooth and submitted to a screwpress in order to obtain cubes of 11·5 centimetres (4 3-5″), and then they should be well tied up with string.

6. These cubes of pressed gauze should be wrapped in red packing-paper and labelled "Sublimate Gauze." The same wrapping up and labelling must be given to sublimate gauze even when prepared in the field.

7. The above given formula for the antiseptic fluid may, in certain cases, be modified according to directions from a surgeon. For use in the field ordinary water may be substituted for distilled water.

8. *Sublimate Cotton Wool for Wounds.*—The directions for preparing antiseptic cotton wool are the same as given in paragraphs 2, 3, 4, and 7, but the cotton wool takes up more fluid than an equal weight of gauze.

9. During the drying process attention has to be given to ensure the wool dries loose and not in a lump.

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* *Krieg's-Sanitaets-Ordnung*, Appendix V., § 63, dated 13th May, 1886.

10. Quantities of 1 kilo. (35 ozs.) of the antiseptic cotton wool, after drying, are to be pressed into packets of 11·5 centimetres, tied with string, wrapped in red paper, and labelled "1 Kilo. Sublimate Cotton Wool." In the medical chests carried with the troops smaller pressed packages of sublimate cotton wool weighing 100 grammes (3 ozs.) will be found.

11. *Sublimate Catgut.*—Catgut should be placed in a 5 per cent. watery solution of sublimate for from 8 to 10 or 12 hours, and afterwards preserved in spirits of wine for use.

12. *Sublimate Silk.*—Silk should be well boiled, and then placed for several hours in a 5 per cent. watery solution of sublimate, to which 20 per cent. of glycerine has been added. It should then be dried and wrapped up in a piece of waterproof cloth. Immediately before use the silk should be placed in a 3 per cent. carbolic solution, or a 1 per cent. sublimate solution.

13. *Antiseptic Drainage Tubes.*—Drainage tubes are to be disinfected by placing them in a 5 per cent. solution of carbolic acid from six to twelve hours, and then preserving them in a fresh solution of the same strength. Should there be only one vessel for holding antiseptic drainage tubes and catgut, then the drainage tubes should be preserved dry, wrapped up in a waterproof material, and only, immediately before use, placed in a 3 per cent. carbolic solution or in a 1 per cent. sublimate solution.

14. *Disinfecting Sponges for Use with Wounds.*—Sponges should be freed from all adherent matter, repeatedly put under a stream of boiling water, well squeezed, and then placed for twelve hours in a 1 per cent. sublimate solution. The disinfected sponges are to be preserved dry in linen bags.

B. *Application.*

The antiseptic dressing at the bandaging place.

(*a*) The dressing of a wound of the lower leg, as an example.

The application of the antiseptic dressing, after any previous needful manipulation as checking hæmorrhage, may be divided into 3 parts:—

1. *First Part—Preparing the Wound.*—Disinfection of the surrounding parts of the wound by rubbing them with a 1 per cent. sublimate solution or a 3 per cent. carbolic solution; irrigation of the wound by means of one of these solutions.

2. *Second Part—The Dressing.*—The wound should be covered with pieces of sublimate gauze, and then the whole leg should be wrapped in layers of sublimate gauze, of at least eight in number. Before doing so, however, a piece of sublimate cotton wool should be placed above and below the wound underneath the gauze, in order to confine the margins of the deeper dressing. Over the layers of sublimate gauze a layer of waterproof cloth is to be placed and the whole maintained in position by a gauze bandage which has been freshly dipped in a carbolic solution.

For a permanent dressing in the hospital the larger waterproof cloth is not required, but the folds of gauze should be more numerous.

The sublimate gauze may in every case be replaced by sublimate cotton wool in a corresponding quantity. If the injury of the leg is complicated by fracture of the bone, then, of course, follows—

3. *The Third Part—The Immobilisation.*—Immobilisation may be done in two ways—

(*a*) By placing the limb in a moulded iron splint (Volkmann); or

(*b*) By making a plaister of Paris bandage over the antiseptic dressing.

If it is intended to apply a plaister of Paris bandage, then the sublimated cotton wool should be used underneath because it furnishes an eminently soft and elastic substratum for the plaister of Paris. Of course, in these cases the dressing must cover the knee and ankle-joints, in accordance with the principles which guide the application of immobilising dressings. *N.B.*—For immobilising limbs in the absence of open wounds, the *common* cotton wool is to be employed as a padding.

C. *The First Dressing Packet.*

The first dressing packet consists of two compresses of antiseptic gauze, 40 centimetres (16") long and 20 cm. (8") broad; of a cambric bandage, 3 metres long and

·5 cm. (2″) broad; a safety-pin and a wrapper of waterproof material, 28 cm. (11″) long and 18 cm. (1″) broad.

In applying a first dressing by means of this packet, the wound is to be covered with the two compresses (gauze in a 8-fold layer), over this the waterproof cloth is placed, and the whole fixed with the cambric bandage and secured by means of the safety-pin.

In case of a simple gun-shot injury with entrance and exit, both openings should be covered each with a compress of gauze and half the waterproof material. Should there not be a sufficiency of first dressing packets at the dressing station, then suitable pieces of waterproof material, about 12 cm. (4¾) square, ought to be kept ready, in appropriate numbers, to be used in addition to gauze compresses, cambric bandages, and safety-pins, in store in the same manner as the contents of the first dressing packets were intended.

Iodoform Dressings.

Simple, not too extensive, injuries may receive a covering dressing of iodoform. The wound is to be dusted over with a thin layer of iodoform, then covered with a gauze compress or some prepared cotton wool, over this a piece of waterproof material, and the whole fixed by means of a roller bandage and safety-pin or by a triangular sling.

APPENDIX IV.

LIST OF SUPPLIES SENT IN EACH BOAT PROCEEDING UP THE NILE, CALCULATED FOR TWELVE MEN IN A BOAT, AND TO LAST 100 DAYS—1884-85.

Net Total for Each Boat.	ARTICLE.	Proposed Daily Issue per Man.
799 lbs.	Preserved corned beef, .	1 lb four days out of six.
192 ,,	,, fresh meat, . .	1 lb. one day out of six.
168 ,,	Bacon, ...	1 lb. one day out of six.
48 ,,	Boiled mutton, ...	
66 ,,	Cheese, ...	¾ oz.
770 ,,	Biscuit, Navy, ...	1 lb. five days out of six.
210 ,,	,, cabin, ...	
200 ,,	Flour, ...	1 lb. one day out of six.
52½ pint bottles	Pickles, ...	½ oz. four days out of six.
17 tins	Jam, ...	1⅓ oz. two days out of six.
17 ,,	Marmalade, ...	
80 lbs.	Tea, ...	1 oz.
240 ,,	Sugar, ...	3 oz.
19 ,,	Salt, ...	¼ oz.
80 ,,	Preserved vegetables, . .	1 oz.
7½ gals.	Lime juice, ...	$\frac{1}{320}$ gal.
432 rations	Erbswurst, ...	1 ration every third day.
49 lbs.	Cocoa and milk, ...	For occasional use.
2 gals.	Vinegar, ...	$\frac{1}{1280}$ gal.
40 lbs.	Rice, ...	
40 ,,	Oatmeal, ...	
10 ,,	Baking powder, ...	
2 ,,	Pepper, ...	
40 ,,	Tobacco, ...	On repayment.
27 ,,	Soap, common, ...	,,
9 ,,	,, carbolic, ...	,,
192 boxes	Matches, ...	
1	Field Hospital Supply Case.*	

DIRECTIONS.

The column for the daily issue shows the data upon which the supplies of each article have been calculated; but, provided the total ration is not exceeded, the various articles may be issued in such proportion as may be considered advisable by Officer Commanding.

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* FIELD HOSPITAL SUPPLY CASE CONTAINED

3 bottles brandy.
3 bottles port wine.
12 4-oz. tins Liebig's extract carnis.
½ lb. mustard.
1 lb. soap, yellow.

1 lb. candles.
1 tin alum.
2½ lbs. arrowroot.
¼ lb. salt.
4 tins condensed milk.
6 tins cocoa and milk.

2 boxes safety matches.
½ lb. compressed tea.
1 corkscrew.
1 opening knife.
1 bottle permanganate of potass.

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